ONTARIO TASK FORCE
ON PROVINCIAL RAIL POLICY

WORKING PAPERS

ANALYSIS – VOLUME II

INTERIM REPORT – SEPTEMBER, 1980

Ontario

MARGARET SCRIVENER, M.P.P.
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TABLE OF CONTENTS

VOLUME I

TABLE OF CONTENTS

VOLUME II

TABLE OF CONTENTS

VOLUME III

FOREWORD

When Members of the Ontario Task Force on Provincial Rail Policy commenced deliberations in January of this year, we wished to survey and evaluate the rail mode as fully as possible within the timeframe provided.

To expedite our investigations, the Task Force called upon various individuals and organizations to produce specific 'working papers' relating to various aspects of the railways and their interaction with our provincial community. Although several papers have been produced by private sector consultants, the vast majority are the result of research and investigation of specialist staff within the Government of Ontario.

The writers were invited to look ahead and, wherever appropriate, offer any recommendations which in their opinion might assist the Task Force in preparing its final report. The response has been gratifying and helpful, and on behalf of the Members of the Task Force I wish to express sincere appreciation to each of the participating Ministries for a job well done.

This resource document contained in three volumes is presented as part of the Interim Report of the Ontario Task Force on Provincial Rail Policy.

Margaret Scrivener.

Margaret Scrivener (Mrs.),
CHAIRMAN.

INSTITUTIONAL

LEGISLATION AND JURISDICTION

PREPARED FOR:

Ontario Task Force on

Provincial Rail Policy

Strategic Policy Secretariat
Ministry of Transportation and
Communications
June 30, 1980.

ONTARIO RAIL TASK FORCE ON PROVINCIAL RAIL POLICY

Task: Legislation and Jurisdiction

Purpose:

1. To document a history of significant legislative and policy changes which have taken place in Canada and Ontario affecting railways.

2. To indicate any current jurisdictional or procedural difficulties which do or might impede Ontario policies or actions with regard to rail transportation

Strategic Policy Secretariat
Ministry of Transportation
and Communications
June 30,1980

FOREWORD

This paper presents a brief overview of significant legislative changes and jurisdictional difficulties which have affected rail transportation in Ontario and Canada.

Although it reflects some original research, primarily with respect to Ontario's involvement in rail up to 1932, it also depended heavily on existing material to describe (a) the federal predominance in rail transport from 1914 to present, and (b) the current situation with respect to jurisdictional responsibility.

Specifically, this paper is indebted to two key works:

- Canadian Transportation Economics (Currie)
- A paper on Issues in Jurisdictional Responsibility and Accountability - Today and Tomorrow (RTAC, October 1979)

Other sources used are included in a bibliography at the end of this report.

It was understood from the outset that this paper would be used to support other parts of the Task Forces' activities. Indeed, this material has been prepared as a useful source document - to ensure that significant historical events in rail transportation affecting Ontario have been placed in proper chronology and perspective as opposed to a paper which will form an integral part of the eventual Task Force Report.

LEGISLATION AND JURISDICTION

(Contents)

PART I

Provincial Involvement in Rail Transport (1867-1932)

In 1867, under the provisions of The British North America Act Section 92(10)(a), the Province of Ontario was delegated authority over any rail activity within its boundaries. Rail operations which extended beyond the confines of Ontario's borders were placed under the jurisdiction of the Dominion. Section 92(10)(c) of the BNA Act blurred this interprovincial-intraprovincial division of jurisdiction. The Federal Government was granted a "declaratory power" which allowed Parliament to claim authority over rail activity within a Province believed to be for the "general advantage of Canada or for the advantage of two or more of the Provinces". In relation to railways within Ontario, the Dominion successfully exercised this declaratory power ninety-seven times, thereby placing various minor railway companies in the Province under federal jurisdiction.

In the decade following Confederation the Ontario Government neglected to introduce any major statute which would clearly define its authoritative role in rail. As a result the sixty-five private railway companies incorporated by the Legislature were subject to the provisions of the Federal "Act Respecting Railways".

In 1877, Ontario clarified its previously ill-defined position in rail with the introduction of "The Railway Act of Ontario". The Act was applicable to every railway company subject to the legislative authority of Ontario which had been incorporated since August 30, 1851 or was to be incorporated after the Act took effect. In the Act, substantial regulatory discretion was left to the private sector. The only regulatory stipulations to be enforced by the Province were specific safety precautions and approval of levied tolls. Otherwise, railway companies could independently determine their level of freight rates, charges for individual shipments and quality of service. Competition was the major source of protection for the needs and interests of the public.

Although the Ontario Legislature had not introduced the Railway Act until 1877, the Provincial Government had passed several rail assistance acts. The Province regarded the railway as a vital instrument for regional and economic development, and therefore was eager to promote an efficient rail system. Rail

not only would contribute to the expansion of such primary industries as pulp and paper, mining and timber but also promote settlement into areas otherwise inaccessible.

Provincial assistance to railway construction took several forms. The "Railway Fund Act" of 1871 and the 1872 "Railway Subsidy Fund Act" offered direct cash donations to any private railway company constructing lines within the Province. The monies needed to constitute these funds were drawn from the Consolidated Revenue Fund of Ontario.

In 1878 the Government of Ontario furthered its financial assistance to rail development with the introduction of the "Railway Aid Act". Under this Act assistance would be granted to certain specified railways which were facing financial difficulties in completing the construction of their rail lines.

Another major source of assistance for rail during this period was provincial land grants. In the "Railway Land Subsidy Fund Act" of 1877 Crown lands were to be offered to rail companies at low cost. The proceeds from the land sales would be placed into a fund in aid of the railways.

By the late 1870's the Provincial Government's subsidy and land grant acts had begun to take effect causing unprecedented growth in Ontario's railway industry. Prosperity was spreading throughout the Province and the desire for more railway facilities was becoming so strong that government control appeared at the time to be relatively unimportant. Several railway companies, unhindered by regulation, began to sell lands previously purchased from the Province at prices higher than settlers were willing to pay. Settlers were also being restricted from homesteading on those railway lands scattered among Crown lands. Public objections toward the Government's land grants program were made in response to these impediments. The Provincial Government then made subsidies the primary form of rail assistance.

By the 1880's the vast amount of subsidies being granted to railway companies caused Ontario's Consolidated Revenue Fund to wear thin. The Province was no longer able to aid railway building as it had in the 1870's. The Ontario Government turned to the Dominion to provide some form of financial assistance for Ontario railways. Ottawa responded by offering certain private railway companies within the Province $3,200.00 per mile of rail line.

By 1897 the policy of guaranteeing bonds of railway companies was the primary way of granting government assistance to railway construction in Ontario. The Provincial Government was still providing subsidies to certain railway companies for construction purposes, but these subsidies carried with them specific stipulations which the companies had to adopt. These requirements included government approval of the company's toll rates and line locations.

The "Electric Railway Act of Ontario" was introduced by the Ontario Legislature in 1895. The Act clarified the Provincial Government's authoritative position over those private rail companies within the Province which were now using electricity as a major source of locomotive power.

In 1902 Ontario's role in rail took on a new dimension. By an act of the Provincial Legislature the Temiskaming and Northern Ontario Railway was incorporated as the Province's first public owned utility. The "T & NO Rail Act" also provided for the establishment of a Commission ordered to construct and subsequently direct the operation of the provincial railway. Although in future years the T & NO rail system was criticized by those it served as being a government monopoly, the "community railway" provided invaluable access and expansion into the northeastern region of Ontario.

An important turning point occurred in Ontario rail in 1906. At this time approximately four hundred private railway companies existed within the Province. Over seven thousand miles of railway had been constructed and was operating. The Ontario Government realized that to continue leaving this vast industry unregulated could threaten the commercial viability of certain rail lines or, indeed, certain primary and secondary industries within the Province.

The move to strong government regulation over rail was ratified by two provincial acts passed by the Ontario Legislature in 1906. The "Ontario Railway Act, 1906" established a vast array of regulatory principles, applicable to all railway companies and railroads (other than government or street railroads) under the legislative authority of the Province. The regulations stipulated in the Act were both economic and safety-related. Rail companies were to obtain government approval of their freight rates, tolls and land purchases. Strict requirements on the number and size of railway cars and engines were specified, as well as rules relating to safety precautions.

The regulation was to be administered by the Ontario Railway and Municipal Board created under the "Ontario Railway and Municipal Board Act, 1906". In its role as a regulatory agency of the Province, the Board was to ensure that railway companies adhered to the regulatory requirements outlined in the "Ontario Railway Act". The Board was also authorized to arbitrate any labour disputes rising within the rail industry of Ontario.

In 1913 the "Ontario Railway and Municipal Board Act" was re-enacted with few changes evident within the legislation. Major rail construction in the Province had diminished so that the duties of the Board were mainly oriented towards regulating the operation of existing lines.

By 1917, Ontario's role in rail was faltering. The recommended consolidation of the Grand Trunk, Grand Trunk Pacific and Canadian Northern into the Canadian National Railways was proposed by the Drayton-Acworth Federal Commission. This amalgamation could seriously hurt rail expansion within the Province. Yet Ontario could not object to such a move by the Dominion Government. The Province had obligated itself so heavily for bond guarantees of those unsuccessful railways that it might have been seriously embarassed if suddenly called upon to meet its obligations.

In the 1920's the Ontario Government further withdrew from its previously active role in rail transportation. The possible construction of a public owned hydro-electric railway system was considered to be an uneconomic venture as it would not be able to successfully compete with the increasingly popular Canadian National Railway. Regulation of Ontario's railways was continued by the Ontario Rail and Municipal Board until 1932 when the Province no longer saw the necessity for such a board. Under an act of the Provincial Legislature of Ontario the Ontario Railway and Municipal Board was revised to become simply the Ontario Municipal Board.

PART II

The Federal Predominance in Rail Transport

The most conspicuous feature of Canadian transportation history during the six years after 1914 was the collapse of the Grand Trunk, Grand Trunk Pacific and Canadian Northern as privately owned enterprises. None of these railways could pay its own under a level of freight tolls which was set on the requirements of Canadian Pacific. Although both Canadian Northern and the Grand Trunk Pacific were private concerns, substantially both of them were the financial responsibilities of national and provincial governments.

A Royal Commission (1917) recommended that the Canadian Northern, the Grand Trunk and the Grand Trunk Pacific Railways be consolidated with other lines wholly owned by the government into a single system later called the Canadian National Railways. This Commission made it clear that the government-owned railways were to be run as a straight commercial concern. However the eventual Board of Directors for the "Separate Corporation" were selected on a regional basis - a method which gave weight to other considerations beyond business capacity or technical qualifications. The groundwork was herein laid for departing from business principles in the administration of CN.

Ultimately the Board of Directors, with the Federal Government's approval, set up the Canadian Pacific as the yard stick for pricing purposes. It was to be operated as a commercial enterprise but the Canadian National with its heavy indebtedness would have to justify itself on the grounds of being a pioneer road, serving all regions and contributing to national unity.

In the 1920's public investment in transportation facilities again reached prodigious amounts. The Federal Government poured money into the Canadian National to rehabilitate and unify the various individual and often competing companies which had been thrown together between 1917 and 1923. The Government also advanced funds to meet operating deficits on the system. This building boom had 3 basic objectives in mind:

- reduce cost of transportation
- open up the country
- keep trade flowing along Canadian routes rather than the U.S.

As noted previously, provincial governments tended to withdraw from further investment in railways after 1920 as the Federal Government assumed their former obligations to the Canadian Northern and Grand Trunk Pacific. Although Ontario had its own local railway, the chief provincial expenditures were on highways.

In the early 1920's railway rates were cut back from their postwar peak. In 1922, the Crow's Nest Pass Agreement was suspended by legislation for a further period of two years except that the rates on grain and grain products from the west to Lakehead were rationed to the 1899 level. In 1925 Parliament extended this arrangement without limit of time. The Crow's Nest Pass Agreement was originally passed in 1897 and essentially reduced freight tolls on grain-related products in Western Canada. These reductions were voluntarily accepted by all rail companies operating in the territories covered by the agreement.

Depression

During the period 1932-35 Canadian Pacific's earnings failed to cover fixed charges which had to be met from reserves. The deficit on the Canadian National grew to the point where it practically equaled all the federal income tax. Capital investment in railways virtually ceased. The provinces continued to spend money on the maintenance and construction of highways though on a much smaller scale than before.

Royal Commission 1931-32

Basically, this Commission, known as the Duff Commission, proposed radical changes in the constitution of the governing body of the Canadian National and voluntary co-operation between the major railroads with a view to cutting out unnecessary waste while retaining the virtues of full competition.

In the end, the Commission gave its blessing to current practice: the privately owned system (Canadian Pacific) was to approach the problems of transportation from the standpoint of profit and loss but the success of the national system was not to be appraised by ordinary commercial standards.

1930-1940

The most significant change during this period was the rapid growth in the volume of goods moving over the highways as compared with traffic by rail. The right of way for highways was, of course, provided by the provinces and paid for by users on a more or less pay-as-you-go basis by means of gasoline taxes.

In 1933 Parliament passed legislation to protect the public against arbitrary abandonment of lines by railway companies. In 1938, Parliament authorized railways to publish agreed changes subject to the approval of the then Board of Railway Commissioners (now the Railway Transport Committee of the C.T.C.) with the object of enabling rail to better compete with trucks.

On the whole, this decade was a period of retrenchment for the railways, of growing control over inland - water navigation and airlines, and of efforts at adjustment between competing transportation agencies.

War and Post War

Under price and wage control measures introduced in late 1941, tolls for the services which railways rendered to shippers and passengers, the price of the materials and equipment they purchased, and the wages of the men employed were all frozen. During this time, of course, the railways assumed the main burden of carrying munitions, troops, civilians engaged in war work, food stuffs for servicemen etc.

The Feed-Grain subsidy started in 1941 as an offer of the Federal Government to pay one-half of the freight charge on feed grains moving from Prairie production areas to the Eastern provinces, provided the Eastern provinces paid the other half. Ontario was, initially, the only province matching the federal grant.

In late 1945 and 1946 the railway situation deteriorated. Cost of operation rose after the end of hostilities and especially following the general lifting of price and wage controls in 1946.

Because of highway carriers again being strong competitors, the railways' revenue began to fall off and caused the railways to seek and obtain a general increase of tolls. These increases, however, were inadequate to meet the financial requirements of the carriers. Wages and material prices continued to rise and increases could not be applied to the sacred export Western grain which was held to a 1899 level under the Crow's Nest Pass Agreement.

Turgeon Royal Commission (1951)

Because of this rail rate increase, dissatisfaction was widespread among shippers especially in the West and the Maritimes. Therefore, the St. Laurent Government appointed a Royal Commission under the chairmanship of the Hon. W.F.A. Turgeon to review the entire problem.

The significant findings of this Commission outlined that rates must be fair and reasonable not only to the railroads but also the shippers and consignees.

The Commission moved significantly from a position of complete pricing freedoms to stating that "experience has shown that such a factor (return on investment) may not be the guiding factor, it may be one which in times of economic depression must give way to other considerations".

The Commission hence gave no provision for protecting railways against political pressure to build new or abandon old lines. Substantially, the Commission concluded with the idea that railways are to be run like the Post Office; that they are to make a profit if they can but that the objective in setting tolls is to cover costs and also to assist in the economic development of the nation.

Although many viewed the Turgeon Commission's approach as being narrow, the St. Laurent Government wasted little time in embodying its main recommendations into law.

A specific result of the Turgeon Commission relevant to Ontario was the Bridge Subsidy. This subsidy applied for nearly twenty years and reduced tolls in the "bridge" area between Lake Superior and Manitoba in Northern Ontario.

1950's

The Korean War touched off a series of wage boosts and led to a sharp rise in the cost of supplies. Business recession in 1954 and 1957 reduced railway revenues below expectations. Hence the railways were forced to apply for further increases in the general level of rates (in fact, there were 14 general increases approved in the years 1948-58 which resulted in an overall increase of some 155%).

When the railways applied for a further increase (12%) in 1959, the Diefenbaker Government appointed a Royal Commission eventually under the Chairmanship of M.A. MacPherson. At this time, the Government also passed the "Freight Rates Reduction Act" which gave the railways a subsidy of $20 million and provided for a roll-back in rates which did not apply to specific kinds of freight rates and passenger fares.

MacPherson Royal Commission 1961

The Diefenbaker Government had hoped that no further action would be required until the MacPherson Report was tabled. However, in the summer of 1960, the railways and unions became locked in a wage dispute with the result that Government passed legislation forbidding any strike on the railways until after May 15, 1961 hoping that the MacPherson Report would be ready by then.

The Commission worked on the premise that competition was now a major factor in Canadian transportation. It contended that the current problems of the railways stemmed from the burden imposed on them when they held a virtual monopoly of inland transport. The Commission's principal concern was to remove the burden of past obligations.

The Commission found 4 major areas where obligations associated with public regulation and attitudes inhibited the railways' competitive ability and inflicted a burden on the users of railway services:

- uneconomic passenger services
- unprofitable branch lines
- statutory and related rates on grain
- statutory free transportation

10.

Consequently, subsidies were called for in these areas until such time as the obligations were removed.

The Commission clearly forecast the problem for public policy:

"The competitive environment in the transportation industry has made it impracticable for the railways to continue to accept the great burden - dictated not by economic consideration but by social, political and traditional pressures - which is involved in the maintenance of rail passenger-train services".

It was not until early February 1967 that Parliament finally passed legislation on the MacPherson Report of 1961. Parliament carried out the main thesis of the report which was that every mode of transport including rail should be operated on business principles.

The policy statement within the "National Transportation Act", which reads as follows, still qualifies the thesis to such an extent that the nation remained in the position of regarding transport as an instrument of national policy as well as a business:

"It is hereby declared that an economic, efficient and adequate transportation system making the best use of all available modes of transportation at the lowest total cost is essential to protect the interests of the users of transportation and to maintain the economic well-being and growth of Canada, and that these objectives are most likely to be achieved when all modes of transport are able to compete under conditions ensuring that having due regard to national policy and to legal and constitutional requirements (a) regulation of all modes of transport will not be of such a nature as to restrict the ability of any mode of transport to compete freely with any other modes of transport; (b) each mode of transport, so far as practicable, bears a fair proportion of the real costs of the resources, facilities and services provided that mode of transport at public expense; (c) each mode of transport, so far as practicable, receives compensation for the resources, facilities and services that it is required to provide as an imposed public duty; and (d) each mode of transport so far as practicable carries traffic to or from any point in Canada under tolls and conditions that do not constitute (i) an unfair disadvantage in respect of any such traffic beyond that

disadvantage inherent in the location or volume of the traffic, the scale of operation connected therewith or the type of traffic or service involved, or (ii) an undue obstacle to the interchange of commodities between points in Canada or unreasonable discouragement to the development of primary or secondary industries or to export trade in or from any region of Canada or to the movement of commodities through Canadian ports; and this Act is enacted in accordance with and for the attainment of so much of these objectives as fall within the purview of subject matters under the jurisdiction of Parliament relating to transportation".

Various interpretations have been applied to this general policy statement, depending on the interest of the stakeholder. The railways have interpreted the Act to give them "pricing freedoms" and to allow them to be preoccupied with maintaining their commercial viability. The Act of 1967 continued the subsidies under the "Freight Rates Reduction Act", federal assistance in anticipation of the implementation of the final recommendations of the MacPherson Report, and the "Maritime Freight Rate Act".

Among other things this Act was critical in terms of giving clearly defined directives to the CTC regarding regulatory provisions covering passenger train discontinuance. Further, the findings of the MacPherson Commission were important in terms of CNR reorganizing its management so that the Passenger Department was separated from the Freight Department. In 1964 CNR had spread its new pricing policy of Red White and Blue Fares throughout its system.

1970's

With specific regard to Ontario, the Toronto Area Transit Operating Authority was created in 1974. This is an example of how a province with Federal Government consent, can exercise a large measure of responsibility in a field that is under federal jurisdiction. This authority is responsible for co-ordinating commuter transit activities around Toronto and has assumed the administrative responsibilities for "GO Transit" which had been operating since 1967.

Perhaps the next truly significant development occurred in 1976 when the Railway Passenger Development Program was established. Through this Program the Federal Minister of Transport proposed that:

(a) in principle, payments for losses would be increased from 80% to 100% to remove the financial burden on the railways inherent in the existing subsidy arrangements, concurrent with the implementation of adequate controls and incentives to ensure efficiency in management operations;

(b) incentives would be applied;

(c) the CTC would review all passenger services to eliminate duplication;

(d) trains would be replaced by commercially viable modes where they are not suitable or well utilized.

This program was perhaps the main achievement of a transportation policy review by the Federal Government in 1975 which looked at all facets of freight and passenger transport in Canada.

As a result of this program, VIA Rail Canada Incorporated was established under "The Canada Business Corporation Act" as a non-comprised subsidiary of CNR. CPR was also represented on the Board. This legislative step was followed by a second key piece of legislation whereby VIA was deemed a railway in 1977 bringing it under the jurisdiction of "The Railway Act".

This gave VIA the powers of a railway and made it subject to regulation by the CTC. This legislation also gave power to the Minister of Transport to contract with VIA for the provision and management of passenger rail services on specific routes.

It permitted VIA to contract with any railway (subject to Ministerial approval) to operate trains on these routes in accordance with VIA's management direction.

When it became apparent that the above arrangement removed from CN all effective control over its subsidiary, authority was granted to the Minister to purchase VIA Rail by "Appropriation Act No. 3" passed in December 1977.

Purchase was completed on March 31, 1978 and VIA became a proprietory Crown Corporation under Schedule "D" of "The Financial Administration Act".

It is perhaps significant to note that measures were not taken, at this time, to modify the Rail Act to relieve the railways of their statutory responsibilities for passenger rail services.

Attempts have been made to modify national transportation policy as has been proposed lately in Bill C-20. The intention in this Bill is to emphasize the "achievement of national and regional, social and economic development objectives and that it is the responsibility of governments to attend to the provision of the transportation system".

PART III

Railway Relocations - Grade Separations, Urban and Commuter Transit

Much of this paper to this point has covered significant legislative changes with respect to traditional passenger and freight rail service. Of more recent significance has been the pressures and demands placed on commuter and transit systems in and around urban areas.

The Railway Act of Canada spells out in great detail the manner in which the federal railway should be operated. It also details the involvement of the Federal Government regarding grade crossings.

As the country became more urbanized, the Federal Government looked for ways to make its presence more known in these areas of concentrated population. Improvements to grade crossings was an area for which the Federal Government had already accepted responsibility. Combining this existing responsibility with new inputs from the Federal Ministry of State for Urban Affairs would result in a significant presence in urban areas.

As substantial urbanization had surrounded railyards across the country, many level crossings required grade separations to eliminate accidents and delay. The Railway Relocation and Crossing Act of 1974 made it possible to correct these problems.

A five year program totalling $250,000,000 was to address the problems of railways in urban areas. However, nowhere near $50,000,000 was spent each year. Although improvements were needed, the provinces often did not have the resources required to meet the federal formula. This money related to parts 1 and 2 of the new Act. Part 3 was the Grade Crossing Fund which had a $5 million annual allocation according to the Railway Act.

The Federal Government next became interested in urban transit systems and announced that the Urban Commuter Services Program was to go into effect in April of 1977 and would provide $100 million towards improving these services. There were complaints that this money would all go to Montreal and Toronto and eventually, the program was dropped.

This did not deter the federal politicians and a new program surfaced, the Urban Transportation Assistance Program (UTAP).

The funding for this program was

(1) $100,000,000 - Urban Commuter Services Program
(2) Uncommitted Funds from Parts 1 and 2 of the Railway Relocation and Grade Crossing Fund
(3) Some unidentified funds TOTAL Canadian 5 Year Program - $229,937,000

As early as 1909, the CTC (as it is now known) became responsible for Rail Crossings under the Railway Grade Crossing Fund in 1909. Through this fund, the Federal Government materially assisted in reducing or eliminating hazards where railways and highways intersect.

The provinces have now been left to decide where funds will be allocated. The eligible items are:

(1) Railway Relocation
(2) Rail - Highway Grade Separations
(3) Urban Transit Capital Projects

The intended effect is a reduction of the federal presence in these fields. Some provinces are continuing with rail grade separations, others are proceeding with urban transit projects and some grade separations.

The Federal Government will no doubt maintain the jurisdiction and the responsibility for these essential railway-related services and facilities. However, the funds available under the UTAP initiative have resulted in sustantially less amounts than had been available formerly on a separate basis. Ontario as well as other provinces have indicated the various shortcomings of the UTAP approach to funding the various important undertakings which are primarily a federal responsibility.

PART IV

Current Status of Transport Jurisdiction In Canada

Given the foregoing historical overview of the significant legislative and jurisdictional changes and difficulties with respect to rail transportation, it is necessary to clearly show the current jurisdictional ownership with respect to various rail activities (e.g. licensing, safety, infrastructure).

The following charts were prepared by a Committee of RTAC in October of 1979:

Rail Mode

Activity	Fed.	Prov.	Munic.	Carrier	Shipper	Othe
a) Infrastructure Provision						
- railbed				x		
- stations and yards				x		
- signals				x		
- adjacent land use	CTC	x	x			
b) Licensing						
- railbed	CTC					
- stations and yards	CTC					
- signals	CTC					
c) Economic Regulation						
- entry	CTC FIRA	x[6]				
- rates and tariffs	CTC PAR[7]	x[6]				
- approval of infrastructure (interprovincial systems)	CTC					
- approval of infrastructure (intraprovincial systems)		x				
- level of service (inter-provincial systems)	CTC					
- level of service (intra-provincial systems)		x				
- subsidy (interprovincial system)	CTC					
- subsidy (intraprovincial system)		x				
d) Safety						
- infrastructure	CTC					
- cars and locomotives	CTC					
- crew				x		
- accident investigation	CTC					
e) Overall Operations						
- rail companies	CTC			x		
- infrastructure	CTC			x		
f) Transfer of Ownership						
- interprovincial system	CTC FIRA					
- intraprovincial system	CTC FIRA	x				
g) Research and Development	CSTA TDC			x		x

6 The provinces may dictate rules and regulations for rail systems which operate entirely intraprovincially.

7 There are some freight rates which are set by federal statute (e.g. the famous Crow's Nest rates)

Public Transit

Activity	Fed.	Prov.	Munic.	Transit	Shipper	Other
a) Infrastructure Provision						
- roads		x	x			
- rail, dedicated right-of-way	CTC[13]	x	x			
- garages				x		
- shelters				x		
- traffic engineering innovations (e.g. exclusive bus lanes)			x			
b) Licensing						
- vehicle		x				
- operator		x				
c) Economic Regulation						
- fare		x[14]	x[14]	x[14]		
- subsidy		x	x			
d) Safety						
- vehicles	x	x				
- operators		x				
- company operation			x			
- vehicle operation			x			
- accident investigation		x	x			
e) Overall Operation						
- maintenance of roads		x	x			
- maintenance of other infra-structure (garages, shelters)				x		
- planning of route structure				x		
- start-up, shut down of route			x			
f) Transfer of Ownership						
- generally irrelevant as almost all transit "companies" are either commissions or municipal departments.						
g) Research and Development		x	x	x		x

13 Where the transit operation occurs on right-of-way owned by a federally regulated carrier, the CTC remains as the regulatory agency.

14 This depends on the provincial policy. In some cases, it is an explicit policy to keep the fares low, while in others it is a policy to recover a specified proportion of operating cost from the farebox. There is usually a policy (and a subsidy) to allow special groups (e.g. senior citizens, handicapped) to ride at a reduced fare.

PART V

Process and Potential Implications of Transferring Certain Transport Responsibilities From One Jurisdiction to Another.

An excellent paper has been prepared on this subject by the Roads and Transport Association of Canada entitled Jurisdiction: Responsibility and Accountability Today and Tomorrow.

Excerpts of this paper have been repeated in the following pages. The purpose of including this section in this report is twofold:

(1) To clearly show the legislative implications of transferring certain powers;

(2) to provide a framework for change of responsibilities and jurisdiction if this was considered desirable by the Task Force.

The second of these is intended to provide the Task Force with a broad range of optional courses if some eventual recommendations pointed to a change of responsibility.

Legislative and Jurisdictional Responsibilities

A traditional point of view is that activities of the Federal Government should be restricted to matters that are essential to ensure that people or goods are able to move interprovincially and internationally as freely, efficiently and safely as possible. The present Constitution fulfills these requirements fairly well, but it appears that actual federal presence in transportation as it exists today exceeds these limits. The provincial governments, on the other hand, do not have jurisdiction in all areas falling within the non-essential federal transportation role; that is, the provinces do not now have jurisdiction in various aspects of, for example, air and marine transportation for purely intraprovincial transportation activities. This was pointed out on the previous charts.

Implicit in the above statement of the essential federal role in transportation are two other assumptions. First, if the Federal Government decides to transfer certain transportation responsibilities to the provinces, this might not necessarily include authority for two provinces to enter into an agreement to extend these responsibilities to transportation between the two

provinces without the Federal Government's approval. In other words, the Federal Government retains legislative jurisdiction over interprovincial transportation, and can exercise its power either directly or by requiring Federal Government approval of interprovincial agreements in the fields transferred. Second, it is also assumed that the Federal Government would not wish to transfer the responsibility for exercising control over Canada's international relations which is under federal legislative jurisdiction by virtue of Section 132 of the B.N.A. Act.

This federal responsibility could clash with provincial jurisdiction, for example, if an international agreement is proposed in a field that is under provincial jurisdiction or partly under provincial jurisdiction, such as education, labour or agriculture.

A further assumption is that the existing provinces will continue to exist as they are today and that in a formal legal sense they will be treated as equals. This is not intended to imply that machinery or measures designed to redress economic inequalities among the provinces will not continue to exist. However, it is recognized that the implications of transferring responsibility over certain transportation elements to the provinces will be quite different for larger provinces like Ontario or Quebec than for smaller provinces like Nova Scotia or Prince Edward Island.

THE SPENDING POWERS OF THE FEDERAL AND PROVINCIAL GOVERNMENTS

In addition to exercising their legislative jurisdiction with respect to transportation, both the federal and provincial governments are able to extend their influence over transportation by means of their spending powers. Generally speaking, legislative jurisdiction over a public service is conceived of as carrying with it the right and responsibility for supporting such services financially, if such support is considered to be expedient or necessary by the government which has legislative jurisdiction.

Under the existing Canadian Constitution as interpreted by the courts, the Federal Government can support financially a service that falls under provincial jurisdiction provided that the federal legislation authorizing the expenditure does not amount to a regulatory scheme falling within provincial powers.

This interpretation of the Constitution legitimizes federal financial contributions for transportation services and facilities even if legislative jurisdiction with respect to such services belongs to the provincial governments.

Federal funds can also be spent in areas of provincial jurisdiction or responsibility with the agreement of the provinces. Examples are the federal cost-sharing programs through DREE and Transport Canada for highways, such as the highway strengthening program in the Atlantic Provinces and the Western Northlands program.

Similarly, a province with Federal Government consent can exercise a large measure of responsibility in a field that is under federal jurisdiction. An example is the commuter rail service operated by CN for the Government of Ontario (GO Transit) in the Toronto area. This service is under federal jurisdiction, yet the Ontario Government through financial intervention makes key decisions, subject to agreement with the railway, in relation to rates, frequencies, fares and conditions of service generally. Hence, a provincial government's spending powers can be used to transfer responsibility for provision of facilities and services from the Federal Government to the provincial government with the former's consent.

It is implicit in the transfer of financial responsibility to provincial governments, however effected, that the Federal Government is prepared to accept variations in the quality of facilities and services provided from province to province, and to accept the pressures that are likely to develop on the Federal Government to intercede to redress the balance either financially or in terms of managing safety and/or economic regulation in some provinces but not in others.

It has often been claimed that the Federal Government has used its large financial resources and its constitutional spending powers to initiate new federal-provincial programs (sometimes not wanted by the provinces), thereby disturbing in some cases provincial priorities. While this may have been true in certain federal transportation initiatives in the past, the general complaint currently is the reverse; that provinces look to the federal government to provide greater financial assistance for certain transportation programs, especially highways and urban transportation.

Limited federal financial resources make the additional provision of funds for these purposes more difficult. Federal tax room and revenues have decreased relative to those of the provinces over the past two decades; for example, in 1958, the Federal Government had 50 percent of all general revenues, in 1978 it had only 45 per cent. In the future, therefore, it appears that the provinces and local governments may have to finance even more of their transportation programs out of their own tax revenues. Exceptions, of course, will still be the rule, especially for high priorities expenditures clearly in the national interest and certain transport expenditures for well-defined regional development purposes.

TRANSFERRING TRANSPORTATION RESPONSIBILITY BETWEEN LEVELS OF GOVERNMENT

From the foregoing, it appears that there are several ways to transfer responsibility for a transportation activity from the Federal Government to the provincial governments or vice versa:

i) A formal transfer of jursidiction can be made between levels of government only by means of a constitutional amendment or revision. This requires the consent of both levels of governments (the Federal Government and the provinces), a difficult process at best despite various efforts to provide for new amending formulas in the B.N.A. Act.

ii) Delegation of administration of federal legislation to another level of government (e.g. transfer of <u>responsibility)</u> for control of a transportation activity can be made by means of a federal act, provided the government (s) concerned are willing to accept the responsibility. The most obvious example of this type is the Motor Vehicle Transport Act. By means of this Act, the Federal Government empowered the provincial highway boards to regulate inter-provincial and international motor vehicle transport and in effect adopted provincial laws as federal laws for this purpose. Although the degree of responsibility transferred by the Motor Vehicle Transport Act may have been consider-able, this device nevertheless may be a useful one with respect to certain transportation activities for which the Federal Government would like to transfer responsibility. The proposals contained in the Transportation of Dangerous Goods Bill illustrate the reverse process whereby the Federal Government would be empowered, with a provincial government's consent, to proclaim that a federal Act applies to specified areas of provincial jurisdiction. One problem

with this reverse process, however, is that it would result in variation from province to province unless all the provinces could agree simultaneously to transfer a responsibility to the Federal Government and could agree on the "dimensions" of the responsibility to be transferred.

iii) A transfer of responsibility from the Federal Government to the provincial governments can also be made in a passive manner, particularly with respect to the provision of facilities and services. The Federal Government would simply make it known that it did not intend to provide the specific facilities or services but that it had no objection if the provincial or municipal governments were to step in to offer financial support.

CURRENT JURISDICTIONAL ISSUES

Current jurisdictional issues have three dimensions:

i) Jurisdiction between the government and the private sector;

ii) Jurisdiction between the Federal Government and provincial and municipal governments; and

iii) Jurisdiction between Government Departments or Ministries and departments and agencies including the Crown Corporations and the Regulatory bodies.

The first jurisdictional dimension, that is the jurisdiction and split between government and the private sector, stems from proposals to have more of the functions currently being performed by the Federal Government carried out by the private sector. This notion of "privatization" is being pursued in a number of ways by Government.

A related aspect of "privatization" is the push towards deregulation and less government; that is, to eliminate or to reduce a government regulatory function and other international activities and to let the private sector operate more "freely". While this implies less government legislation and regulation, it does not necessarily lead to a final dimunition of government jurisdiction and responsibilities; most Canadians would expect government to intervene again if the private sector performed unsatisfactorily, however defined.

The second jurisdictional dimension, that is the jurisdiction between various levels of government, essentially consists of the need to renegotiate areas of overlap or duplication between the federal, provincial and municipal governments and ultimately creating a more understandable division of responsibilities. It implies a clear answer to a definitional question: What is the essential federal role in transportation?; leaving it to the other levels of government to meet provincial and municipal transportation needs.

As discussed above, it has been assumed that essential federal jurisdiction in transportation should relate to ensuring that people or goods are able to move interprovincially and internationally as freely, efficiently and safely as possible. There are a number of areas where federal jurisdiction may not be essential. These include an analysis of the implications of transferring such functions to the provinces and will have to consider such factors as costs, safety, standards, etc. But consideration will also have to be given to the longer-term impact on interprovincial differences in financial and administrative capacities and activities and the nature and efficiency of transportation firms and services.

Another aspect of the Federal Government's role in transportation relates to the notion of "local autonomy"; the concept of allowing greater scope for areas where ultimate jurisdiction and authority will continue to remain with the Federal Government.

The third and final dimension of jurisdiction, that is, the division of responsibilities between Transport Canada on the one hand, and other federal departments, Crown Corporations and the Canadian Transport Commission, on the other hand, is an equally complex one. First, there has been some uncertainty with respect to the Minister of Transport's power and process of policy direction to major Crown Corporations such as CN and Air Canada which impact on Ontario. Second, since 1967 there has been a confusion in the overlapping role between the Department of Transport and the Canadian Transport Commission in areas of policy advice and program implementation. Third, from time to time the roles of other departments, such as DREE and DPW, in transportation is confusing in relation to the functions and activities of the Department. In total, these jursidictional issues have demanded some clarification and many initiatives are accordingly underway.

Appendix 1

SOME SELECTED FEDERAL RAIL ACTS

1. Atlantic Region Freight Assistance Act

- to authorize assistance to transportation in the Atlantic Region;
- Governor-in-Council may authorize the payment of assistance out of the Consolidated Revenue Fund to truckers in respect of the movement of goods by them in a calendar year from points within the select territory to points in Canada outside the select territory;
- notwithstanding anything in the Maritime Freight Rates Act, the Governor in Council may vary or remove the reduction in tariffs for the preferred movements of traffic as described.

2. National Transportation Act

- to define and implement a national transportation policy for Canada;
- applies to transport by railways to which the Railway Act applies; by air to which the Aeronautics Act applies; by water to which the Transport Act applies and all other such transport to which the legislative authority of the Parliament of Canada extends; by a commodity pipeline connecting a province with any other or extending beyond the limits of a province; for hire or reward by a motor vehicle undertaking connecting a province with any other or beyond the limits of a province;
- sets up Canadian Transport Commission;
- Commission may make rules and regulations respecting, e.g., the carrying on of the work of the Commission, the management of its internal affairs, and the duties of its officers and employees; may exercise and perform on behalf of the Minister such powers, duties or functions of the Minister under the Canada Shipping Act as he may require, etc.; may make rules and regulations for the attainment of the objects of this Act respecting, e.g., the manner in which any committees of the Commission shall perform.

3. Railway Act

- Canadian Transport Commission approves the location of railways, etc., and may e.g., whenever the railway is to be carried over any navigable water by means of a bridge, direct construction of the bridge; if the CTC grants permission for the railway line or trucks of one company, to be crossed or joined with those of another company, it may e.g., give directions as to the supervision of the construction of the works; may order or permit the railway company to lay water and drainage pipes, provide farm crossings or exempt it from erection and maintaining fences, gates and cattle-guards. It may e.g., make regulations regarding fire protection; re limiting the speed at which trains may be run in any town, etc; regarding the use of the whistle within any town; designating the number of men to be employed upon trains, with a view to the safety of the pulic and employees; may disallow any freight rate that after investigation the Commission determines is not compensatory; may set range for fixed rates for shipping goods; may prescribe passenger tolls; may order any telegraph or telephone line in any municipality to be placed underground, etc.; may settle disputes regarding supply of electricity where water-power has been acquired under lease from the Crown, etc.; may gather information regarding e.g., its assets and liabilities, etc., from any railway, or express company and may make it public; and has the like powers to repeal, rescind, change or vary such regulations and orders, as in the case of regulations and of orders that the Commission may make under this Act or the National Transportation Act.
- The CRTC now administers those parts of the Railway Act which deal with the regulation of telephone and telegraph within federal jurisdiction.

4. <u>Railway Relocation and Crossing Act</u>

- to facilitate the relocation of railway lines or rerouting of railway traffic in urban areas and to provide financial assistance for work done for the protection, safety and convenience of the public at railway crossings;
- Canadian Transport Commission <u>may make rules for applications regarding urban development and transportation plans</u> and may by such rules prescribe the periods during which applications will be received by the CTC and may adopt an order of priorities governing the receipt limit of any such applications; may require a railway company to cease to operate over any line within the transportation study areas to which the transportation plan relates and if considered desirable or expedient, to remove any tracks, buildings etc. from the land occupied by the railway company within that area; may e.g., require a railway company to build a railway line in such a location as may be specified by the CTC within the transportation study area to which the transportation plan relates, or to make any connections between such railway lines or any rapid transit or public transit systems with the transportation study area as may be specified by the CTC.

Appendix 2

CHRONOLOGY - A SELECTED LIST OF KEY DIRECT LEGISLATION AND ROYAL COMMISSIONS AFFECTING RAIL TRANSPORTATION IN ONTARIO

1867 - British North America Act Section 92 (10a) (10c)

- federal responsibility in rail which interconnects provinces or extends beyond the limits of the provinces
- provincial jurisdiction restricted to rail existing within provincial boundaries
- "Declaratory Power" granted to the Dominion over rail within a province declared by the Parliament of Canada to be for "the general advantage of Canada or for the advantage of two or move of the provinces".

1871 - "Railway Fund Act"
- creation of the Ontario Railway Fund

1872 - "Railway Subsidy Fund Act"
- creation of the Ontario Railway Subsidy Fund

1877 - "Railway Land Subsidy Fund Act"
- creation of Rail Land Subsidy Fund from the sale of Crown lands to rail companies

1877 - "The Railway Act of Ontario"
- defining Ontario's authoritative role in rail
- discretionary powers granted to private railway companies

1878 - "Railway Aid Act"
- financial aid to be granted to certain specified rail companies

1883 - "Street Railway Act"
- street railway companies and rail lines are to be subject to provisions of the Municipal Act
- are the responsibility of municipalities

1895 - "Electric Railway Act"
- similar to the provision established by "The Railway Act of Ontario, 1877"
- applicable to railroads operating by means of electricity

1897 - The Crow's Nest Pass Agreement which essentially reduced freight tolls on grain and grain-related products in Western Canada

1902 - "Temiskaming and Northern Ontario Railway Act"
- creation of the public owned provincial Temiskaming and Northern Ontario Railway
- establishment of a commission to construct and direct the operations of the provincial railway

1906 - "Ontario Railway Act, 1906"
- regulations to be applied to all railways under the legislative authority of Ontario, other than government and street railroads

1906 - "Ontario Railway and Municipal Board Act"
- creation of the Ontario Railway and Municipal Board as a regulatory agency of the province

1909 - Railway Grade Crossing Fund established by Federal Government

1913 - "Ontario Railway and Municipal Board Act, 1913"
- reinforcement of "Ontario Railway and Municipal Board Act, 1906"
- few significant revisions

1917 - Royal Commission recommended consolidation of lines into a single system (Canadian National Railways)

1921 - Hydro-Electric Railway Commission
- to investigate possibility of creating a public owned Hydro-Electric rail in the Province of Ontario

1922 - Crow's Nest Pass Agreement suspended by legislation except on grain and grain products to the Lakeshore

1925 - Parliament extends this agreement (Crow's Nest) without limit of time

1927 - "Ontario Railway and Municipal Board Act, 1927"
- reinforcement of previous acts with minor amendments

1927 - Parliament passes the "Maritime Freight Rates Act" providing a 20% subsidy to certain freight traffic in the Maritimes

1927 - "Railway Act of Ontario, 1927"
- incorporates all previous acts
- no major relevant amendments

1931 - Royal Commission (Duff Commission) which eventually proposed radical changes in the constitution of the governing body of the Canadian National

1932 - "Ontario Municipal Board Act"
- creation of the Ontario Municipal Board

1933 - Parliament passes legislation to protect the public against arbitrary abandonment of lines by railway companies

1938 - Parliament authorizes railways to publish agreed charges subject to the approval of the Board of Railway Commissioners

1941 - "Feed-Grain Subsidy" enacted by Federal Government

1941 - Wage and price control measures freezes railway tolls

1951 - Turgeon Royal Commission called as a result of a series of rail rate increases imposed since the 1941 freeze

1951 - Bridge Subsidy applied to traffic in Northern Ontario north of Lake Superior

1957 - Amendment to "Maritime Freight Rates Act" allowing for reductions of some 30% on certain shipments

1961 - MacPherson Royal Commission called as a result of rail increases requested since Korean War

1961 - "At-and-East grain subsidy" applied to bulk grain for export moving in carload lots from points on the Great Lakes, Georgian Bay and St. Lawrence to export ports in Canada

1967 - Parliament passes "The National Transportation Act"

1970 - Parliament passes "The Atlantic Assistance Act"

1974 - An act to create the Toronto Area Transit Operating Authority (TATOA) receives Royal Assent

1975 - Major Transportation Policy Review undertaken by the Federal Government

1976 - VIA Rail Canada Incorporated established under "The Canada Corporations Act" as a non-comprised subsidiary of CNR

1977 - VIA is deemed a railway under the jurisdiction of "The Railway Act"

1978 - VIA becomes a proprietory Crown Corporation under Schedule "D" of "The Financial Administration Act"

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SOME NOTES ON

ONTARIO PUBLIC POLICY ON

RAIL TRANSPORTATION

Prepared for:
Ontario Task Force on
Provincial Rail Policy

Strategic Policy Secretariat
Ministry of Transportation and Communications

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CONTENTS

ONTARIO PUBLIC POLICY ON RAIL TRANSPORTATION

Introduction

The starting point selected for this research was the files of proceedings of the senior executive committee (Strategic Policy Committee) of the Ministry of Transportation and Communications.

References to rail policy or allied matters contained in those records have been traced back to their source and/or forward to their documentary output. Where then were found to have substance or relevance, they are summarized in this paper. The records examined date back to January 1976. Decisions of the Strategic Policy Committee's prodecessor, known as the Policy Committee of the Ministry, have also been examined back to the time of the amalgamation of the Departments of Highways and Transport in 1971.

This method of research obviously has limitations. For example, replies made in answer to questions in the Legislature or policy statements emanating from sources other than the Ministry of Transportation and Communications may not have been captured.

The most extensive expression of Ontario policy on rail is contained in the submission of the Government of Ontario to the Royal Commission on Transportation (known as the MacPherson Commission). This submission, which is dated March 14, 1960 predates by ten years the period of research, but it is important in any consideration of Ontario Rail Policy, not only because of its comprehensive coverage of the subject, but also because it was, in the opinion of its authors, the first declaration of policy on this subject by the Province:

> "This is, I believe, the first submission ever made by Ontario on railway transportation. It is of a very general nature and does not attempt to deal with specifics - It does, however, endeavour to set forth curtain basis observations and principles."

(See Note 1.1)

It is, therefore, an appropriate foundation on which to frame the present discussion.

The report and recommendations of the MacPherson Commission were the basis of The National Transportation Act, passed by Parliament in 1967. Subsequent Ontario rail policies have been developed in reaction to federal and national rail moves to implement the intention of this Act. Ontario also proceeded with a number of initiatives which have less direct relationship to the federal jurisdiction. These initiatives have arisen through the growing interest of the Province in mass transit triggered by consideration of the future development of the heavily populated Toronto/Hamilton area and the need for energy conservation.

Convergence of federal and provincial interests in rail transportation during the 1970's gave rise to greater and more frequent communication between the two levels of Government at three Ministerial and staff levels and before federal regulatory bodies, in both Canada and the United States. The nature of these communications varied from meetings of the Ministers to the establishment of joint Committees and Task Forces and formal interventions by the Province at hearings of the Canadian Transportation Commission and the United States.

Ontario's posture in respect of rail transportation policy has developed from apparent disinterest in the years immediately prior to 1960, through "observations and principles" at the time of the MacPherson Commission and active involvement in the 1970's, to recognition of the need for precise definition which is currently being undertaken by the Task Force on Provincial Rail Policy. It should be pointed out, in the full historical context, that the Government of Ontario had a deep interest in rail policy in the earlier decades of this century through the creation and development of the Temiskaming and Northern Ontario Railway in 1902, now the Ontario Northland Transportation Commission, and the general development of rail services throughout the province during the late 1800's.

This paper attempts to itemize the policies expressed and implied by the Government of Ontario during the 1970's against the background of the 1960 Submission to the MacPherson Commission.

2. MacPherson Commission

Although its full title was "The Royal Commission on Transportation", the main thrust of the Commission's work appeared to be directed to the rail mode. Certainly, the submission made by Prime Minister Frost in person on behalf of the Government of Ontario was wholely devoted to rail policy and rate structures.

The submission did not attempt to establish a definitive position for the Province. It accepted that rail was a Federal responsibility. The reasons for making the submission was expressed in the following words:

> "The whole aim and purpose of this submission is to lend the weight of this Province to support a wise and constructive national railway policy; one looking to the future and not one condemned to futility because it tries to re-create a past which is gone forever."

(See Note 2.1)

Noting that the "era of buoyant growth (of the railways) came to an end in the second decade of this century", the point was made that "the railways which, at one time, could bend the economy to suit their operating convenience" could no longer do so. Railway philosophy and practice during this period was summarized as:

> "Traffic was delivered to the railway; eventually it was received by the consignee; but the intervening period of highly uncertain length was set so as to minimize the movement cost which the railway had to bear, not to maximize the value of the service."

(See Note 2.2)

The representations made by Ontario for consideration of the Commission relate to lack of planning in the discontinuance of service (i.e. the need for rationalization) and the adverse effects of the existing rate structure on certain sectors of the economy of Ontario.

The first of these concerns is summed up:

"Over the past score of years, I have seen and watched the almost total dissolution of any practical railway service to the people of vast areas of Ontario."

(See Note 2.3)

Several observations were made as to how this situation could be rectified:

- "... if there were fast, flexible operations between the more outlying parts of Ontario and the larger cities there would be many people who would use rail services rather than the bus or truck transportation on our highways";

(See note 2.4)

- "The fact that the railways perform a public service may on occasion necessitate a continuation of a particular operation in the absence of economic justification";

(See Note 2.5)

- "The railways, as any other industry, must change with the times or atrophy".

(See Note 2.6)

In respect to rate structures, the submission states:

"... we have an important stake in the railway systems of this country and in the rates and other means by which they are financed. The establishment of rates that would result in the restriction of this Province's trade would not only adversely affect Ontario, but indeed, the whole of Canada."

(See Note 2.7)

In this connection, a number of statements appear which outline the concerns of the Province:

- "... in Northwestern Ontario, railway rates, aggravated by horizontal increases, can be a serious impediment to the development of its resources, the export of forest and mineral products and also to established trade channels and markets in that part of the Province";

  (See Note 2.8)

- "As long as there is any cross-subsidization in railway rates the burden is likely to fall upon those areas where geographical location and the character of their production tend to make them dependant upon the railway for service";

  (See Note 2.9)

- "A policy which penalizes progress and which seeks by overcharging on the movement of goods on some lines to compensate for loss on others will in the end prove self-defeating";

  (See Note 2.10)

- "If there must be subsidization of some traffic we suggest that it be not at the expense of other users but that it be segregated and met out of the nation's tax revenues";

  (See Note 2.11)

- The most serious inequities in the rate structure at the present time are those which flow from attempts to enjoy the benefits of a value for service rate structure when changes in the Canadian economy have destroyed the basis on which it rested".

  (See Note 2.12)

The foregoing amply illustrate the attitude of the Province towards the problem at the time of the Submission (March 1960). As stated earlier in this Paper, it is expressed in terms of "observations and principles" not in concrete recommendations. One final quotation exemplifies this:

> "The Province of Ontario would urge upon the Commission the inescapable fact that reconstruction of railway assets and railway service as is here recommended cannot be produced by compulsion".

(See Note 2.13)

3. The National Transportation Act

The MacPherson Commission gave rise to the passing by Parliament of The National Transportation Act. This Act sets out, in Section 3, the philosophy of the Federal Government in transportation matters.

The policy of the Ontario Government in respect of rail transportation, since passage of the Act in 1967, has been reactive to federal action designed to further this philosophy. It, therefore, is appropriate to reproduce the relevant section.

> "It is hereby declared an economic, efficient and adequate transportation system making the best use of all available modes of transportation at the lowest total cost is essential to protect the interest of the users of transportation and to maintain the economic well-being and growth of Canada, and that these objectives are most likely to be achieved when all modes of transport are able to compete under conditions ensuring that having due regard to national policy and to legal and constitutional requirements
>
> (a) regulation of all modes of transport will not be of such a nature as to restrict the ability of any mode of transport to compete freely with any other modes of transport;
>
> (b) each mode of transport, so far as practicable, bears a fail proportion of the real costs of the resources, facilities and services provided that mode of transport at public expense;
>
> (c) each mode of transport, so far as practicable, receives compensation for the resources, facilities and services that it is required to provide as an imposed public duty; and
>
> (d) each mode of transport, so far as practicable, carries traffic to or from any point in Canada under tolls and conditions that do not constitute

i) an unfair disadvantage in respect of any such traffic beyond that disadvantage inherent in the location or volume of the traffic, the scale of operation connected therewith or the type of traffic or service involved, or

ii) an undue obstacle to the interchange of commodities between points in Canada or unreasonable discouragement to the development of primary or secondary industries or to export trade in or from any region of Canada or to the movement of commodities through Canadian ports;

and this Act is enacted in accordance with and for the attainment of so much of these objectives as fall within the purview of subject matters under the jurisdiction of Parliament relating to transportation."
(See Note 3.1)

In 1972, the Province intervened in several applications to the Rail Transport Committee for adjustment of specific freight rates. The Ontario position, as expressed in the Interventions in two of these cases, is set out below:

1. IN THE MATTER of the Application of the Saskatchewan Wheat Pool, Agra Industries Limited, Co-Op Vegetable Oils Ltd. and Western Canadian Seed Processors Ltd. pursuant to Section 16 of The National Transportation Act.

   known as the Western Rapeseed Processors Case

   - "The Government of the Province of Ontario has intervened in this application due to its possible detrimental effect of the crushers of rapeseed and soya beans located in Toronto and Hamilton, Ontario."

   - "The freight rates applicable to the products of the western crushing industry, must reflect the inherent geographic disadvantages and the added distance to the eastern market (compared with their eastern competitors who are domiciled in the geographic centre of the market.

- "During the General Rate Investigation 1925/7, the Board stated "It has been laid down as a principle that the Board's function does not extend to the removal, by adjustment of freight rates, of these natural geographical disadvantages, which, in a country of such enormous extent and widely covered area (as Canada), must naturally exist."

This principle has been re-enunciated in The National Transportation Act:

- "The granting of the application would further result in creating an unfair advantage in favour of the Applicant's to the detriment of the Ontario industry."

- "The granting of this application would be neither in the National, Regional or Provincial "public interest" and would be contrary to the objectives of The National Transportation Act."

(See Note 3.2)

2. IN THE MATTER of the Application under Section 23 of The National Transportation Act by Anglo Canadian Pulp and Paper Mills Ltd. et. al.

   - "The interest of the Government of Ontario in these proceedings arises from its responsibility to the public of the Province to foster the development and maintenance of transportation rates which encourage the development of primary and secondary industries in Ontario and which promote export trade from the Province.

     The importance of the newsprint industry to the economic well being of Ontario requires the development of transportation rates which do not inhibit the growth or expansion of the newsprint industry in the Province."

   - "The Province of Ontario submits that the granting of lower rates to the Applicants without thorough consideration of the effect of such action on other communities and regions similarly dependent upon the newsprint industry would be to risk severe economic disruption with the likelihood of net socio eonomic disbenefit to all but the Applicant group.

The public interest of the Province of Ontario requires that the relative competitive position of the Newsprint Mills of Ontario not be worsened by any adjustments made to the rates of the Applicant mills.

The Province of Ontario submits that any relief granted to the applicant mills will necessarily result in a deterioration of the competitive position of the Ontario mills unless equivalent relief is granted to Ontario Newsprint Producers.

The Province of Ontario submits that to the extent that the Commission affords relief to the Applicants, it ensures that appropriate and comparable relief by afforded the Ontario Mills who would otherwise be adversely affected by such decision."

(See Note 3.3)

In time, it became apparent to the Federal Government that the policy declared in The National Transportation Act, was not, in itself, producing the desired cohesive transportation system for Canada. As a consequence, much staff work was done and, early in 1975, a number of statements of policy emanated from Ottawa.

The Minister of Transportation and Communication commented on this flurry of activity in a statement to the Legislature on May 02, 1975:

- "Mr. Speaker:

Honourable members will undoubtedly have noted recent press releases and statements by the Federal Minister of Transport concerning studies presently underway by his officials toward the preparation of a new comprehensive National Transportation Policy. On February 17, of this year for example, Mr. Marchand told the House of Commons in response to a question:

"The policy which I hope can be announced shortly will cover not only the Regional Air Carriers, but it will cover the third level Air Carriers, the Railways, the Highways -- it will cover everything that moves in Canada."

I believe that it is appropriate for me to take this opportunity to inform the House concerning the views of the government of Ontario respecting these developments, especially since I have been informed by persons in the transportation industry that Federal officials have given the impression that Ontario is actively involved in the definition and the conduct of these studies."

- "I must confess that I personally am still rather unclear as to the objectives and the time frame of the Federal study. If its objective is simply to resolve internal questions such as the power of the federal minister to set overall policy for the various transportation agencies which report to him or to resolve specific national scale questions of undoubted federal competence such as the capacity of the railroads through the Rockies, the requirements for a Canadian merchant marine, or the retirement of the Seaway debt then the federal initiative is appropriate.

- "But if, as I suspect, the Federal government is proposing to make decisions on a broader and more detailed scale which will directly affect this Province and its ability to make appropriate use of transportation to achieve its own legitimate economic and social objectives, then the active participation of Ontario is required. The Federal government does not have a mandate covering "Everything That Moves In Canada", nor do the broad objectives of the Federal Government make it an appropriate body to embark upon a unilateral review of policies which will have a direct impact upon the regional development of this Province or the service requirements of Ontario Municipalities."

- "The Government of Ontario is in no way opposed to the idea of a comprehensive review and an updating of national transportation policies, although from our perspective we have been reasonably satisfied with the operation, within Ontario, of The National Transportation Act and with its underlying principles of inter-modal competition. While we would not go so far as the Federal Minister's statement that national transportation policy "is a mess" we do agree that there are a number of problems which are of concern, a number of them related to Northern Ontario."

- "Ontario also recognizes that solutions to transportation problems must be coordinated to make the best use of available modes irrespective of formal jurisdiction. It is especially important under current economic conditions that there be a rationalization of the use of the taxpayer's dollar between governments to prevent wasteful expenditures at cross purposes".

- "For these reasons, Ontario welcomes the idea of a comprehensive review of transportation policies in Canada but believes that this review, to be successful, must come to grips with the fundamental question of responsibility -- of which level of government should be involved with which aspects of transportation services."

- "Let me underline my belief that the issue is no longer a simple question of legal jurisdiction but of ensuring that each level of government in Canada has the ability to guide and direct transportation services where appropriate to service its own legitimate social and economic objectives. This may well mean such things as greater federal involvement in the Trans-Canada Highway or greater Provincial authority over third level air and regional rail services."

(See Note 3.4)

In implementation of their policy, the Federal Government adopted as a main thrust the rationalization of railway transportation. This thrust was described by the Hon. Otto Lang on January 29, 1976 in a release entitled "Highlights of Passenger Rail Policy." Excerpts follow:

- "Where passenger trains are poorly suited to the market, or poorly positioned, the Government intends to encourage other modes to replace them."

- "Rail service would also be continued in remote areas where no other transportation alternatives exist."

- "About 20 percent of the rail services now operated carry 10 passengers or less per train on the average."

- "CN and CP duplicate service on more than 2,000 miles of routes."

- "The directives to the Canadian Transport Commission are aimed at a total rail passenger plan to be developed in progressive stages by 1978. These stages are outlined as follows:

(1) early action on local or regional cases where no major public need for continuation of service is obvious;

(2) transcontinental service between Western and Central Canada by late 1976;

(3) service between the Maritimes and Central Canada by 1977;

(4) the remainder, including regional and inter-city services not dealt with previously, by 1978.

Plans for each stage should include implementation schedules such that the new basic network of passenger rail services should be in place and operating not later than 1980."

(See Note 3.5)

This statement indicates the areas where Ontario has formulated, adopted and announced provincial policies, each of which will be discussed separately, viz:

- Transcontinental Rail Rationalization and VIA Rail
- Rail Service Discontinuances
- Service to Remote Areas, Notably the North-East Corridor
- the Windsor - Quebec Corridor

a) Transcontinental Rail Service and VIA Rail

Rationalization of the CN and CP transcontinental rail services has been a major part of the federal thrust to put rail transportation generally into a competitive position in accordance with the principles set out in The National Transportation Act.

Because of the routing of the transcontinental lines through Northern Ontario, this issue is inextricably involved with provincial concerns related to service to remote northern communities, the Ontario Northland Railway and transportation in the Northeast corridor generally.

The Province's position in respect of this matter was made known to the Legislature in a statement by the Minister of Transportation and Communications on June 14, 1976. The full text of this statement is included as Appendix I, since it is relevant to all the issues mentioned above. However, the following extracts, which particularly relate to transcontinental rail are reproduced below:

- "At the same time I shall advise the Minister of the importance Ontario places on rail passenger service as well as the position my officials will be taking at the Canadian Transport Commission's hearings in Ottawa commencing at the end of the month. The latter, of course, focuses on the rationalization of the CN-CP transcontinental rail passenger services."

- "In the matter of the CTC's economic rationalization hearing on the CN and CP transcontinental passenger rail services, I shall inform Mr. Lang that Ontario supports in theory the principle of such rationalization. This is on the assumption, however, that rationalization does not involve the transfer of financial responsibility of replacement services to the Province of Ontario.

- "Nor will our support imply acceptance should there be discontinuance of portions of the transcontinental which currently provide an essential service to our northern communities.

- I shall insist that should the CTC rule in favour of discontinuance in such areas, these services must be replaced by local rail or acceptable alternate services tailored to fit the affected communities needs."

On May 2, 1977, the Federal Government issued its "Preferred Plan for Western Transcontinental Passenger Train Service". The Ministry of Transportation and Communications prepared a position

paper on the subject which, by direction of Cabinet, was submitted to the Canadian Transport Commission. The main points in the Provincial position are summarized below:

"SUMMARY OF RESPONSE TO THE PREFERRED PLAN

Ontario's Basic Position

The Province of Ontario must stand opposed to "The Preferred Plan for Western Transcontinental Passenger Train Service" as issued on May 2, 1977 unless the concerns stated below are satisfactorily addressed in the Final Plan expected in the Fall 1977.

Ontario's General Concern

The Final Plan must make specific provision for consultation with this Province to ensure that negative impacts on Ontario's residents are minimized and that positive benefits of rationalization are maximized.

Ontario's Specific Concerns

1. The Toronto/Sudbury/Northeastern Corridors

- Ontario recommends that the Final Plan, recognize the need for the intergration of the Transcontinental Service, through appropriate schedules, with a feeder service to the Cochrane-Timmins-Kapuskasing areas, complemented by appropriate regional services in this corridor, which includes Toronto-North Bay.

- Ontario also recommends that a specific directive be given to VIA to coordinate, and by ticketing, schedules, etc., to facilitate integration of Transcontinental with these regional and feeder services.

- Ontario recommends that specific criteria and guidelines be given in the Final Plan to ensure a full assessment of the benefits and disbenefits of the Sudbury-Toronto Trial Service as a basis for service modifications during the trial, and as a prerequisite for any consideration to discontinue or replace the service.

2. The Northern Communities

- We recommend that the Final Plan provide for a redesigned service which would more adequately accommodate the local and through travel needs of Northern Ontario. This would require convenient access and schedules, and turnarounds at selected intermediate Towns in Northern Ontario. Such a redesigned service must also recognize this Province's legitimate social and economic interests in this region of Ontario.

3. The Viability of the Intercity Bus Industry

- Ontario recommends that the Final Plan contain a directive that precludes the setting of rail fares at levels which would in any way jeopardize the viability of Intercity bus operations in this Province.

4. The Transfer of Financial Liability to Ontario

- We submit that the Final Plan must guarantee that there will be no transfer of financial liability from the Federal to the Provincial level of Government, and, that the savings achieved through rationalization in Ontario be allocated to offset the costs to the Province of other transportation services required.

5. VIA's Flexibility and Further Consultation with Ontario

- Ontario submits that the Final Plan must give VIA sufficient flexibility and a clear directive to consult directly with this Province in order to detail the implementation of the Final Plan and its objectives while fully considering Provincial Policies, Requirements and Concerns."

(See Note 3.6)

The "Final Plan", which was released by the Canadian Transport Committee in October 1977, largely met the concerns raised by the Province. However, the matter of VIA fares jeopardizing the viability of Intercity Bus operations (see Specific Concern 3, above) is still an issue and was raised in correspondence between the Minister of Transportation and Communications and the Federal Minister of Transport (Hon. Donald Mazankowski) in September 1979.

b) Rail Service Discontinuances

This was not a new problem. As noted in Section 2, the elimination of service from "vast areas of Ontario" was stressed in 1960. Since that time, the railways had continued to terminate unprofitable services and routes on economic grounds. The Rail Rationalization policy, however, legitimized these discontinuances from the federal government viewpoint.

The Province of Ontario clearly stated its position in this matter in a Submission to the House of Commons Standing Committee on Transport and Communications at its hearing held in South-Western Ontario in 1972:

> "It has been and is now the position of the Government of Ontario that no passenger train service should be discontinued unless and until a comprehensive coordinated analysis of the inter-relationships between the various modes of passenger transport in Canada has been carried out. This embraces the concept of a total passenger transportation market that must be rationally allocated among the various modes of passenger transport. The Government of Ontario believes that the passenger transport system in Ontario and in Canada cannot be developed on an ad hoc basis. It is our position that the future requirements for passenger transportation demand a coordinated approach to the supply of these facilities. We believe that until the requirements for a minimum passenger network have been determined, it is illogical to hear any applications for discontinuance.
>
> We further believe that such an inquiry must be related to a coordinated study of the inter-relationships of various other modes of available passenger transport. Only in this way can the aim of the National Transportation Act, that is, to achieve the most "economic, efficient and adequate transportation system making the best use of all available modes of transportation at the lowest total cost," be attained. What is required then is a plan embracing all modes of transport, a yardstick against which any application for discontinuance could be measured. Surely, in this stage of our development, it is unacceptable for a

regulatory tribunal to deal with an application for discontinuance of one mode of transportation without a through understanding of the effect of such a discontinuance on the region involved.

In Canada jurisdiction over the various aspects and modes of transportation are divided between the Federal Government and the Provincial Governments. Railways for instance are largely a matter for Federal regulation while highways are within the scope of Provincial jurisdiction. It is the position of the Government of Ontario that investigations and studies of the sort that I have referred to must be carried out jointly by the two levels of government. As a Provincial Government we find ourselves placed in the position of having to react to decisions of Federal regulatory agencies and being expected to fill the vacuums caused by their decisions. Such a process is both illogical and wasteful. Many of the resulting problems could be avoided by studies of the nature that we have suggested and by prior consultation between the two levels of government.

I referred earlier to the definition of the work "uneconomic passenger train services" as enunciated by the Canadian Transport Commission. It is defined by the Commission as "one which is incapable of being rendered profitable to the railway under any feasible alterations in railway operating practices, equipment assignment, scheduling, pricing, or other aspects of passenger service under railway control." It is the position of the Government of Ontario that such definition is unacceptable as it is too narrow and in fact excludes the very considerations which are most important in determining whether a passenger train service should be continued. That definition assumes that the entire range of benefits produced by a passenger rail service can be captured in the profit and loss ledgers of a railway company. An example of an economic benefit that can and does accrue from the operation of an efficient passenger rail service is increased industrial and commercial investment. This economic benefit, of course, does not turn up in the railway companies' revenue accounts; it is none the less real. Industry is unlikely to locate in an area

which is deficient in passenger transport facilities. The loss of such an industrial or commercial undertaking represents a cost or a loss to the community involved, which is not charged to the railway's account.

How do you place a cost on the increased air pollution which results when a passenger train service is discontinued and the abandoned populace takes to its cars? Is it possible to place a value on the cleaner air which results when an efficient passenger rail service is reinstated and those cars stay in their garages? Such benefits are difficult or impossible to quantify but they are none the less real economic benefits that we submit must be included when determining whether a passenger rail service is "uneconomic" or not."

(See Note 3.7)

The Provincial response to decisions by the Canadian Transportation Commission is exemplified in the following quotations:

- "In January 1976, the Honourable Otto Lang, Federal Transport Canada Minister announced a Program to Rationalize Rail Passenger Services in Canada.

  This Rationalization process was to have included CTC Hearings and Subsequent Reviews of each of the Federally-Subsidized services in Canada. The way it was explained to us, the objective of these exercises was to reduce the growth subsidies being poured into rail passenger services.

  At this point, I should tell you that the Ontario Government was present at both the Hearings concerning the Services to be affected in the North.

  Our position on the Sudbury-Sault Ste. Marie Service was that the CTC should completely satisfy itself that the bus service along the corridor be adequate to handle all existing rail traffic plus present and anticipated bus traffic.

  The decision signifies the CTC's acceptance of the adequacy of bus service in this corridor.

At the Thunder Bay-Winnipeg hearing, we stressed Mr. Lang's directive to the CTC -- which said: "Rail passenger service should not be abandoned in any case where no other commercial service exists".

I would like to point out, Mr. Speaker, that there are a number of small communities in this corridor, including Sapawe and Kashabowie, and while they have road access as well as rail, they do not have bus connections.

And when you add to that the fact that there are a number of summer camps and resorts along the line, such as Owakonze, as well as several year-round residents at various points, it becomes clear to us, at least, that these people rely on rail for connections to the outside world.

Yet the CTC Order, in effect, cuts them off.

Expressed in other words, the CTC has completely ignored Mr. Lang's policy directive to provide public service to those places without alternative commercial service.

Such communities may seem comparatively small to some people, but this government will continue to support them until we have concrete assurances that their problems have been solved in the area of transportation services.

I can tell this House, candidly, that till the very day that these two decisions were announced, the Federal Government has not reacted to our offer, made during the Hearings, to sit down and discuss the alternative solutions they must provide to these communities in the case of abandonment."

- "Mr. Speaker, the Minister of Northern Affairs and I feel that the needs of these communities must be assessed further -- and a mutually acceptable solution reached.

In order to allow the Federal Government and the Provincial Government enough time to properly assess these needs and find solutions, Mr. Bernier and I will be requesting the CTC to delay the termination of the service until at least September 30, 1977.

To be sure, there has been one encouraging note. Since the CTC's announcement, these has been some indication that the Federal people are ready to talk about alternatives.

My staff and staff members of the Ministry of Northern Affairs are now following this up."

(See Note 3.8)

- "We are similarly concerned about the recent CTC decision to discontinue the Canadian Pacific service from this city westward to Sault Ste. Marie and the CN service from Thunder Bay North via Fort Frances to Winnipeg. We made our concerns known and I have recently been informed that the service between Sudbury and Sault Ste. Marie will be allowed to continue until the matter can be throughly reviewed.

  With respect to the Thunder Bay to Winnipeg route, we have appealed the discontinuance and here, a two-month extension to July 31 is in effect.

  We are currently reviewing this situation and will continue to press the Federal Government for adequate rail service. If rail service is to be curtailed anywhere, it must be replaced by an adequate combination of rail, bus and/or air service."

(See Note 3.9)

And, although this applies to freight rather than passenger services:

"Toronto -- Minister of Transportation and Communications James Snow today advised the Canadian Transport Commission of his Ministry's concern resulting from a Canadian Pacific application to abandon a 37.3-mile section of track and freight service between Saugeen, westward via Priceville, Durham, Hanover to Walkerton.

CP applied for the abandonment on June 28.

"My Ministry has already informed the CTC of our genuine concern over the potential impact on area industries -- industries which rely heavily on freight service to supply raw materials, particularly in the manufacture of furniture," said Snow.

Snow added that "I have also asked my Ministry's Economic Policy Office to carry out a detailed study to determine specifically how many industries would be affected should CP be granted permission to abandon its service.

"For example, while I know trucking is the alternative, I have to know what effect that kind of freight mode would have on the cost structure of finished goods; what effect abandonment would have on employment; and precisely how many industries now served by CP would be involved.

"The CTC members must understand that stretch of track is of vital importance to the many small plants and industries which are so vital to the prosperity of towns and villages which constitute the viability of rural Ontario."

"It may make fiscal sense to CP to abandon the Saugeen to Walkerton track, but if it's going to upset the income-service balance in the area, it doesn't make any sense at all."

(See Note 3.10)

c) <u>Service to Remote Areas - the North-East Corridor</u>

This subject, to some extent, is intertwined with the concerns of the Ontario Northland Railway (see Section 4). It has been the position of Ontario that a vigorous role for the north, in terms of settlement and economic development, is not only fundamental to provincial policy but also, it has been believed, congruent with national objectives.

In a letter to the Federal Minister of Transport dated December 2, 1977, the Minister of Transportation and Communication described three basic principles of the Province in respect of rail access to remote areas. These were:

"1. There should be no transfer of financial liability from the Federal Government to the Provincial Government as a result of rail discontinuance;

2. No community with existing rail service should be left without some form of public transportation service;

3. The Province's responsibility in transportation should not extend into the area which historically has been federal responsibility, unless the Province is adequately financed by the Federal Government for its expanded role".

(See Note 3.11)

These statements constituted the Province's terms for carrying out the commitment made by the Hon. J.W. Snow in a statement in the Legislature on June 14, 1976:

"--- the Ontario Government re-affirms its previously stated position to improve rail passenger service into the North and Northeast areas of the Province ---

--- The uncertainties concerning funding, discontinuance hearings, transcontinental rationalization and equipment needs are seriously impairing this Government's ability to reach any real and meaningful decisions in rail transportation to the North and Northeastern areas of the Province."

(See Appendix I)

At about the same time, the Minister had stated in a public address:

"While travelling through the North, many people have expressed to me their very real concerns that as a result of the Canadian Transport Commission's recommendations, crucial passenger rail service across the North via the Canadian National tracks will be cut back.

We find it both shocking and impossible to accept that the Federal Government's heralded new VIA Rail plan which was supposed to improve rail service actually curtails rail service in Ontario. This is the kind of help we can do without.

We have insisted -- and will continue to insist -- that designing of a service better suited to the needs of people anywhere along a route as well as those residents on any feeder routes is the criterion that should be used. We want them to assess it in human terms rather than purely in economic terms."

(See Note 3.12)

The current (1980) position with regard to the Northeast Corridor is that Transport Canada would provide an update with respect to its position on this issue and that further discussion between Transport Canada and the Government of Ontario would take place concerning possible trade-offs.

d. Windsor-Quebec Corridor

In March 1976, Provincial staff became involved in a Federal Windsor-Quebec corridor study, with specific concern for the integration of rail and bus systems and rail crossing components. They also sat in consultation on the marketing, infrastructure, equipment and costing procedures sections.

On May 20, 1976, the Federal Government announced that the Quebec-Montreal portion of the corridor would be developed first. To this announcement the Province reacted as indicated in Appendix II. "Statement in the Legislature by Hon. James Snow, Minister of Transportation and Communications, May 20, 1976." The most significant portion of this Statement is reproduced below:

"These federal initiatives were greeted with considerable enthusiasm by my Ministry -- because we, too, recognized the opportunities that existed, particularly in the Toronto-Windsor segment of the corridor. And we felt that, as a result of the proper integration of new passenger transportation modes, we could tie an efficient and economic passenger system serving all the western counties.

In addition, this potential re-assessment of passenger transportation would have permitted us to redress the problems created by the discontinuance of rail services in the Grey-Bruce area in 1970.

Now, today, we have been told that the initial efforts will only include the Montreal-to-Quebec City corridor.

Mr. Lang's statement, flying in the teeth of the fact that the Toronto-Windsor segment serves the densest populated area with the highest economic potential along the entire length of the originally proposed corridor, as I stated earlier, leaves me very disappointed."

(See Appendix II)

Following this Statement, the Minister sought a meeting with the Federal Minister of Transport and, in announcing to the Legislature that this meeting was to take place on June 29, 1976, he made the following remarks:

- "Specifically, I am determined to obtain a clear understanding of the Federal Government's position vis-a-vis the future of the Windsor-to-Toronto corridor."

- "At the time I pointed out that the Federal Government's decision to leave the Toronto-to-Windsor corridor until -- and I again quote from Mr. Lang's telegram -- the near future -- end of quote -- ignored the basic fact that the Toronto-Windsor segment serves the most densely populated area in Canada. It was, I reminded him, also the area with the highest economic potential."

(See Appendix I)

The current situation in this matter is unchanged. During the debate on the Ministry's 1980/81 Estimates, the Minister of Transportation and Communications said:

"I certainly do have discussions with the Minister of Transport. We have been continually pushing for the upgrading of the corridor between Quebec City and Windsor, which we feel is one rail corridor that can be improved and on which the ridership can be increased."

(See Note 3.13)

e) Grade Crossings

One final matter of negotiation with the Federal Government remains to be covered -- that of the Railway Relocation and Crossing Fund. For over sixty years the Federal Government has supplied funding for the relocation of railway lines and the elimination of grade crossings. The amount was not large and was allocated on the basis of proven need, as put forward by the provinces.

When the Federal Government first announced the Urban Transit Assistance Program during the 1974 federal election campaign, it was understood to be a discrete and separate program (see Section 5). However, in 1976 UTAP was combined with the Grade Separation Program, forcing the Province to establish priorities as between individual projects having different objectives.

The Minister of Transportation and Communications described Ontario's reaction to this federal move, in a Statement in the Legislature, on December 17, 1976.

- "Essentially, the Federal Government now proposes to lump these urban transit-related programs with its railway relocation and crossing program and let them compete for a limited amount of money -- an annual allotment to Ontario of approximately $16.5 million.

  In contrast, Ontario had expected to receive at least $16.5 million to meet its most urgent priorities in grade-crossing alone.

  For that reason -- if no other -- we cannot agree it's logical to insist that the dollar costs of all these other programs be met from such a limited allocation.

  And don't forget -- in contributing to grade-crossing safety projects, the Federal Government is only discharging its responsibilities which grow out of its jurisdiction over railways.

  In plain language the objectives in the grade-crossing program are quite different from those of the urban transportation assistance program.

We expressed our views quite strongly to both Mr. Lang and his colleague, Mr. MacDonald. For only they can decide whether or not they can find the funds necessary to discharge their obligations and join us in our program aimed at increasing the use of urban transit.

I am sure, however, Mr. Lang now recognizes our viewpoint that the two programs are totally unrelated and must remain separate. I say that because he did intimate he would lift the freeze on priority grade-crossing approvals immediately.

Without any extensive discussion, it is obvious that this offer falls far short of the amount that Ontario will require to meet its needs for grade crossing work alone."

- "I'm aware, of course, that Mr. Lang, like all of us, faces problems of funding restraints and cutbacks which, to a certain extent, tie his hands.

  But at the same time, I must emphasize that both the objective of our grade-crossing program and the objectives of our urban transportation programs are too important to sacrifice."

(See Note 3.14)

Federal/Provincial Ministerial meetings continued but with no result, as is shown by the following excerpts from a Statement to the Legislature by the Minister of Transportation and Communications on October 31, 1977:

- "Last July 4, I again met with Mr. Lang to discuss this project and I came away with the impression that enough Ottawa funds would be available, over and above announced programs, to cover interim improvements -- to both commuter rail facilities at the Toronto terminal and to inter-city rail service.

  It was my understanding that these funds were over and above allocations for rail relocation and grade crossings."

- "First of all, the Federal proposal reverts completely to the same proposals that were made last August -- that is to lump urban transit related programs and railway relocation and crossing programs in one fund."

- "And these funds are expected to cover:
  - Rail grade separations on provincial and municipal roads;
  - rail relocation studies;
  - implementation of these studies;
  - commuter rail assistance;
  - urban transportation assistance.

  As far as Ontario is concerned, this is expecting too much from too little."

- "Let me explain - in 1976 Ontario and its municipalities received over 14 million dollars in federal assistance under the railway grade-crossing program. In 1977 this assistance should total approximately $18 million. Priorities at the moment for new grade crossing work indicate that the Province and its municipalities are expected to apply for federal funding of approximately $20 million in 1978. $24.4 million in 1979 and $28.2 million in 1980. This totals approximately $72.6 million dollars over a three year period. And this is a conservative figure. The new program would provide a maximum of only $49.5 million."

- "And it is disappointing becuase this is an area in which the Federal Government has participated for over 60 years -- because it recognized its responsibility for -- and jurisdiction over -- railways.

  Obviously, the Federal Government assumes that this $16.5 million a year will also cover the implementation of rail relocation studies.

  We feel that this is an unrealistic expectation. There are currently three of five proposed pilot studies approved and underway.

We need an opportunity to examine the results of these studies before we can come up with a meaningful estimate of implementation costs. We have pressed for an opportunity to base funding responsibilities on a sound knowledge of the facts.

Obviously, we are not going to get it."

- In light of the present announcement we will have to consult with the Municipalities to review the advisability of continuing with the rail relocation studies now underway. And under these circumstances it would appear unlikely that any new studies could be initiated.

  As a consequence, the future of the railway relocation program is seriously in doubt -- to the detriment of our urban trnasportation program, Ontario municipalities and the people of the Province."

- "In addition, the grade separation program will be more difficult to administer. Federal approval on specific projects will still be required. And more municipal programs will have to be reviewed by the Province to establish priority."

(See Note 3.15)

The Province's decision was to use all the available funds for Grade Separations. The Rail Relocation projects which had been studied and prepared for submission to the Federal Government were postponed. This policy was explained to the municipalities on February 21, 1978 in the following terms:

- "One area where we will have to work closely with the Municipalities to determine the level of spending is the railway grade separation program.

  You will recall I wrote to you in December, outlining details of the proposed federal urban transportation assistance program. I would like to confirm that the Province intends to apply as much of the funds as possible to railway grade separation projects.

Most of you have submitted your project priorities to my Ministry, and we have sent a preliminary list to the Federal Government for approval. We are pressing the Federal Government on a daily basis for approvals -- which are absolutely necessary without delay, if we are going to get a grade crossing construction program up and running, and make the best use of the limited federal funds available.

I regret to tell you our efforts have been in vain, to date. The Federal Government continues to procrastinate about the funding arrangements, and the proposed procedures remain far too complex.

If the current federal proposals become a reality, this will make it necessary for the Province to control the overall billings to the Federal Government -- and this is far from ideal.

Whatever constraints the Federal program places upon us, we will try to minimize the inconvenience to you, in the municipalities."

(See Note 3.16)

The situation with regard to federal funding of rail crossing separations remains unchanged. The Minister of Transportation and Communications stated, during the debate on the Ministry's 1980/81 Estimates:

- "In 1978 and 1979, the $16.25 million was cut as some kind of a measure to save money in Ottawa. I believe in 1978 it was cut to about $6 million, and in 1979 to about $11 or $12 million. We were told we would still get the $82.5 million over the five years, but it would be made up in the last three years."

- "We told the Federal Government this is a totally inadequate program for what it is meant to do, but we will assign all our UTAP money to grade separations. We will not use any of it for transit or other things."

- We said we would use it all for grade separation and we've been allocating practically all of that money to municipal grade separation. On our provincial roads, any place where we are building an overpass on a provincial highway qualifies for that money just as a municipal one does, but because of a lack of funds we've gone ahead with a lot of our provincial highway jobs without applying for UTAP funds, because there just wasn't enough there."

- In other words, we're leaving the federal funds available to municipalities and we've been paying 100 per cent of a lot of grade separations that we've been doing."

(See Note 3.17)

4. The Ontario Northland Railway

This railway (originally known as the Temiskaming and Northern Ontario Railway -- T and NO) was established in 1902 by the Ontario Government "to open up New Ontario by truck colonization roads and railways in order to make homes for the sons of Ontario, who otherwise might seek a home in another Province or under a foreign flag". (See Note 4.1)

Ten surveys had been commissioned by the Government at a cost of $40,000. Their report of 1901 stated:

> "It has been established beyond controversy that in the Eastern part of the territory north of the Height of Land there is an immense area of excellent agricultural land ... equal in fertility to any in older Ontario... the forests would enable Ontario to take a leading position in the... pulp and paper-making industry".
>
> (See Note 4.2)

In 1919 the newly-formed Canadian National Railway was faced with the need to sustain traffic on the old Canadian Northern Railway running from Parry Sound to Sudbury. This line had been nationalized in 1917. In order to achieve this objective the CNR formed the intention of diverting the "National" -- a train which ran three times a week from Toronto to Winnipeg -- from the T and NO route between North Bay and Cochrane to the Parry Sound-Sudbury route and thence via Fort William to Winnipeg.

Ontario reaction to this proposal was immediate. Premier Hearst sent messages to the Acting Prime Minister and to the Minister of Railways and Canals in Ottawa, saying:

> "Any action such as suggested would be strongly condemned by a very large portion of the people of the Province".
>
> (See Note 4.3)

The proposed change was prevented. This particular statement of policy has especial significance because a similar situation has arisen in recent years. A discussion of this modern event will be found later in this Section.

Extension of the railway to Moosonee was first suggested as early as 1902. The objective was to enable Ontario to develop a northern ocean port. The Government accepted this project when it was raised again in 1921 but with reluctance. Support was withdrawn in 1923. Premier Howard Ferguson and his government believed that Ontario railways had already been extended far enough into the northern wilderness. The Premier, in announcing that further extension of the line must be postponed indefinitely, stated:

> "The Dominion of Canada is today suffering from the tremendous burden of debt incurred by building railways far in advance of the country's need and we must continue to bear that load of non-productive investment for a great many years".
>
> (See Note 4.4)

The line was completed in the early 1930's, the necessity to create make-work programmes being the deciding factor. Howard Ferguson wrote to George L. Lee, Chairman of the T and NO Commission, on July 29, 1930:

> "In view of the present unemployment situation I think this work should be continued this year. If we were to stop work now and turn away hundreds of men, it would only aggravate the present difficult labour situation".
>
> (See Note 4.5)

Against this background, recent developments in relation to the Ontario Northland Railway must be examined. As a result of the federal policy of rail rationalization, arising out of the passing of the National Transportation Act (See Section 3), the status of the Toronto/North Bay line which was operated jointly by CN and ONR on a pooled equipment basis, came into question.

On June 14, 1976, the Minister of Transportation and Communications stated in the Legislature:

> "As the members of this House may or may not be aware, I am scheduled to meet with the Federal Minister of Transport Canada, the Honourable Otto Lang, on the 29th of this month.
>
> Among the several items on our agenda will be my Ministry's concern in the area of rail transportation in this Province ...

Decisions arising from the Transcontinental rationalization hearings could possibly have an effect on the operations of the ONR as well.

And I shall again make the Minister of Transport Canada aware of such possibilities.

For example, should there be a reconfiguration of the transcontinental rail route through Ontario, it could include the Toronto-to-North Bay link which ONR operates with CN on a pooled equipment basis.

Thus, should this kind of reconfiguration result, I would insist that ONR and CN equipment be compatible.

I shall therefore ask Mr. Lang to make me fully aware of the Federal position in this area as soon as possible.

I shall stress the fact that the Ontario Government re-affirms its previously stated position to improve rail passenger service into the North and Northeast areas of the Province.

Such services can only be considered in their totality -- from Toronto-to-Cochrane and beyond; the branch lines to Moosonee, Noranda and Timmins. Yet -- and I shall point this out emphatically to Mr. Lang -- the Toronto-to-North Bay, as well as other corridors, is the responsibility of the CN -- with its attendant Federal funding.

Thus, regardless of our resolution, any action taken to upgrade the ONR's services must be coordinated with the Federal Government and the CNR ...

Firstly, will be the matter of mandatory discontinuance hearings. In this area it would be rather foolish of the Province to make large capital investments for new equipment while the threat of a Federal discontinuance hearing exists.

Hence, I shall ask for either a five-year deferral of the passenger service discontinuance hearing on CN corridors to enable us to move ahead -- or hold the necessary hearing immediately.

Secondly, I will ask for assurances that Federal funding be continued on the Toronto-North Bay passenger run.

Thirdly, I shall request that the CTC approve Federal subsidies for ONR passenger service deficits on the same basis as those provided the CN portions.

On this subject, while the ONR does not operate under a Federal charter, there is plenty of room for considering a request for subsidies. The ONR does, in fact, serve many remote northern Ontario communities and, if I may quote Mr. Lang himself in a directive dated January 29th of this year: Quote -- rail passenger service should not be abandoned in any case where no other commercial service exists -- end of quote.

That, I shall argue, offers justification for Federal funding for the ONR.

As for our commitments to provide the North and Northeast with upgraded and improved services, I shall make it abundantly clear that the uncertainties concerning funding, discontinuance hearings, transcontinental rationalization and equipment needs are seriously impairing this Government's ability to reach any real and meaningful decisions in rail transportation to the North and Northeastern areas of this Province.

Therefore, the time has come for action -- if we are to respond to the genuine desires and needs of people resident in the North and Northeast. To this end, it is the firm intention of the Government of Ontario to adopt a new equipment schedule which will allow us to order three late model trains anytime before the end of this year".

(See Appendix I)

Despite federal refusal to impose the 5-year deferral on the passenger service discontinuance hearing, the Province went ahead with the provision of new equipment for the ONR.

The policy of the Ontario Government with regard to provision of passenger service in Northern Ontario was summarized by Premier Davis in 1977:

> "In the case of the Ontario Northland Railway, which Ontario owns, we are trying to set an example of responsibility by improving passenger service, while the Federal Government cuts back on passenger services under its control.
>
> Since 1971, Ontario Northland has added a whole range of new first-rate passenger equipment including --- 4 deluxe trans-European express trains which will provide the Northland passenger service --- if necessary, the system will be expanded to provide service in other parts of Northern Ontario."

(See Note 4.6)

5. Commuter Rail Transit

Direct involvement of the Province in the rail mode falls into two main areas: the Ontario Northland Railway and Commuter Rail Transit. The first of these has been separately considered in Section 4 of this paper.

Commuter rail transit, up to the present day, has been confined to that area of Southern Ontario which provides the commuter shed for Metropolitan Toronto. Provincial interest in this transportation mode was first shown in the initiation of the Metropolitan Toronto and Region Transportation Study (MTARTS). The findings of this Study therefore provide an appropriate starting point for discussion.

In its third report, the Technical Advisory Committee to MTARTS ennunciated certain principles which, in its own words, "can be stated as elemental to a transportation policy in a rapidly growing metropolitan community". Two of these principles are worthy of re-statement here as background to the subsequent development of commuter rail networks:

- "There is a need to stress the essential role of public transportation as a prime carrier of people in the heavily travelled corridors. Public transportation systems must be established as an essential public service and as an instrument of public policy"; and

- "Together, the facilities for public and private transportation make up a single urban transportation network. Evolving policies and practices should be directed toward eliminating the unnecessary competition of transportation services and toward improving the integration and coordination of these services."
(See Note 5.1)

During the course of the MTARTS study, GO Transit, the Provincial commuter rail system along the lakeshore corridor from Whitby to Oakville was initiated as a pilot project. An important policy decision was reached during the planning of the system.

In their presentation to the MTARTS project, the Canadian National Railway suggested that there were two alternatives for the use of CN right-of-way for rapid transit service. These were:

"(1) Operate rapid transit over existing or additional railway-used trackage;

(2) Make sufficient land available on railway right-of-way to construct double track rapid transit lines".

(See Note 5.2)

The second of these options was recommended by the railway on the grounds that it would be difficult to avoid delays to the two quite different types of transport if they operated on a common trackage.

However, the consultant engaged by MTARTS to examine and plan the proposed system did not agree with the CN opinion and expressed his preference for alternative (i) above. His report states:

"Fixed Facilities. The requirement for additional track and signal facilities would be negligible since surplus capacity will be available on the Lakeshore line when most freight operations are transferred to the new CNR Classification Yard at Maple early in 1965".

(See Note 5.3)

Government accepted the recommendation of the Consultant and MTARTS, with the result that the GO Transit system does not own or operate any exclusive trackage to the present day.

Before leaving the subject of MTARTS, it is worth noting the recommendation of the Technical Advisory Committee respecting the further extension of the Committee Rail Service.

"B.3 The Committee recommends that extension of the commuter rail system be conditional on there being:

(a) firm plans for a high degree of operating integration with other transit facilities.

Transit and rail services should be arranged to feed and complement each other. Without this mutual support, the role of rail will be restricted.

(b) a regional growth plan aimed at concentrating potential rail users and destination centres along selected corridors.

To achieve rail passenger volumes sufficient to justify high service levels, development control should be highly selective, aimed at securing strong alignment of travel demand."

(See Note 5.4)

This recommendation was adopted by MTARTS and Government. The resultant policy may be accepted as the basis for the inauguration of Toronto Area Transit Operating Authority, a system of GO Transit bus routes feeding and extending the Commuter Rail service and the Bramalea/Georgetown and Streetsville/Milton rail services. (The latter due to open in the Fall of 1981.)

Further reference to commuter rail policy is to be found in the various outputs from "Design for Development: the Toronto-Centred Region". While these are not specific, they are indicative of the thinking at the time and, for the most part, still hold true today:

- "The land transportation serving the Lakeshore corridor will require extensive additions and should incorporate all the various transportation modes - highways, rail, air, air-cushioned tracked vehicles, hovercraft, etc", and

- "The existing Highway 400 and the proposed Highway 404, together with the proposed GO Transit extensions north, must be carefully defined to ensure an appropriate pattern;"

(See Note 5.5)

- "As the Prime Minister (sic) stated on June 3rd of this year (1970):

  if we are to serve, adequately and sensibly the transportation needs of the Toronto area ... we must place our reliance on means and methods other than those which will encourage and proliferate the use of the passenger car as the basic means of transportation".

- "Including in the Metro Centre developments will be one of the region's major transportation terminals"; and

- "...we are anxious that our mass transit options are not diminished by any proposals for the redevelopment of the North Toronto (CP Railway Station) which might limit these facilities for the possible future use of an upper tier regional transit system"; and

- "We are encouraged by the degree of cooperation we have received from the federal Ministry of Transport with respect to the review of existing rail lines for possible future commuter use"

  (See Note 5.6)

- "Decentralizing development in this way improves particular requirements on the design and performance of the region's transportation system. Frequent contacts will be required during working hours between businesses located in the sub-centres and those in the central city. These contracts require a transportation system providing high-speed efficient service. Such a service must be distinguished from the normal commuter service, and may be provided most effectively by rail"; and,

- "Of increasing concern to the government is the energy consumed by alternative forms of transportation, and the growing need to consider this factor in planning new facilities. ...the capacity of the Lakeshore service is already being increased significantly through the use of double-decked coaches ...".

  (See Note 5.7)

These two studies, MTARTS and the Toronto-Centred Region, have established the ground rules, so to speak, for the Province's involvement in commuter transit including the rail mode.

Arising out of this involvement was the whole question of obtaining federal funding assistance for transit which crystalized into two main issues:

(1) the Federal Urban Transportation Assistance Program (UTAP), and

(2) the renovation of the Union Station in Toronto and its adaptation for commuter use.

The UTAP proposal was first made by the Federal Liberal party during the 1974 election campaign and was repeated in 1975 and 1976. It was welcomed by the Provincial Government as a means of making possible the realization of its policies described earlier. The main points of the proposed Federal program were outlined in a release made by the Minister of Transportation and Communications on July 2, 1975:

"Here, then are the main points from the Prime Minister's announcement of the Liberal party program for urban transportation:

- The Liberal Government will pay 100 per cent of the cost of new commuter vehicles manufactured in Canada and 50 per cent of the cost of new stations and platforms forming part of the system.

- Financial support will be made available to encourage Canadian design and engineering of top quality urban and suburban transit vehicles, systems machinery and equipment.

- For Canada's smaller municipalities, the Liberal Government will offer assistance not only in design, engineering and financing, but additional help in the form of expert advice in bringing new transit systems into operation.

- Canadian industry will be encouraged to develop "off the shelf" standardized systems and equipment, such as telebuses and urban commuter trains which can save Canada millions of dollars in development costs and encourage Canadian transport designers, engineers and manufacturers to become world leaders in their field.

- The Liberal Government will encourage urban transit systems innovations, including further demonstration projects financed by the Federal Government.

- The Liberal Government is committed to removing the 12 per cent sales tax on all twelve-passenger and up vehicles which provide services as part of municipal transit systems.

- The Liberal Government will offer the best use of existing railway rights of way and track in urban and suburban areas for new commuter and urban transit lines with a view to reducing the high initial cost of such systems to Canadian municipalities.

(See Note 5.8)

These promises were not fulfilled and the UTAP funding became consolidated into the Railway Relocation and Crossing Program (See details in Section 3). The Provincial position with regard to the federal refusal of assistance for urban transit was articulated as follows:

> "Essentially, the Federal Government now proposes to lump these urban transit-related programs with its railway relocation and crossing program and let them compete for a limited amount of money -- an annual allotment to Ontario of approximately $16.5 million.
>
> In contrast, Ontario had expected to receive at least $16.5 million to meet its most urgent priorities in grade-crossings alone.
>
> For that reason -- if no other -- we cannot agree it's logical to insist that the dollar costs of all these other programs be met from such a limited allocation.

And don't forget -- in contributing to grade-crossing safety projects, the Federal Government is only discharging its responsibilities which grow out of its jurisdiction over railways.

In plain language, the objectives in the grade-crossing program are quite different from those of the urban transportation assistance program.

...our viewpoint that the two Programs are totally unrelated and must remain separate"

(See Note 5.9)

To complete the discussion of UTAP, it is sufficient to say that the situation remains the same at the present writing and there has been no change in either Federal or Provincial policies.

The re-development of the Union Station is tied in with the abortive Urban Transportation Assistance Program, but its history is somewhat different as is explained in the following statement made in the Legislature by the Minister of Transportation and Communications on December 17, 1976:

"From its inception, the Federal Government cooperated with the Provincial Government in evaluating the needs of the Toronto Transportation Terminal. They also cooperated in the development of a plan which would permit the much needed expansion of urban transit services; the continued efficient operation of federally controlled rail service; and the introduction of the improved inter-city passenger service.

Federal Ministers have agreed on several occasions that a cost-sharing arrangement be drawn up, laying out Federal and Provincial contributions for the design and re-development in this area".

(See Note 5.10)

This project suffered from the general cutback of funds for UTAP.

The Governments immediate reaction to the cutback is expressed in the following extracts from a speech made by the Minister on May 1, 1977:

- "This has dealt a serious blow to the planned Toronto Terminal and TATOA's plans for more GO Rail service";

- "Obviously, these federal cutbacks will not permit GO Transit to make optimum use of existing rail corridors";

- "Thus, at this time we will have to consider a total freeze on any funds previously earmarked for the Union Station project".

(See Note 5.11)

However, the results of this consideration was that the strategic importance of GO Transit made it essential that improvements be made to the Union Station without federal assistance, albeit on a limited scale:

- "I am not exagerating when I say that we are convinced GO Transit is of strategic importance to the network of Metro and Area regions";

- "Together these railway rights-of-way constitute a 'natural' resource and, Ladies and Gentlemen, such a natural resource must be utilized for the benefit of all the communities along that line";

- It therefore follows that we must have adequate, efficient transportation ...";

- If rail transportation is not available, then we must build highways and arterial roads at costs we cannot accept -- costs in environmental intrusion: costs in air pollution: costs in intensely wasteful energy consumption by the private car: costs in the loss of production land paved over for roadways and parking lots".

(See Note 5.12)

- "This announcement forces us to continue to go it alone on commuter and urban public transportation and on improvements to Union Station. The need for these programs has been clearly demonstrated. Therefore, we see no other solution but to proceed. Particularly with plans to improve Union Station and the rail corridor so that the bi-level coaches will be able to operate as part of the GO Transit operation. But we will have to cut back significantly on our plans for this program"

(See Note 5.13)

It is appropriate to note that, during the period of the Progressive Conservative Government of Prime Minister Clark, the Minister of Transport, Hon. Don Mazankowski agreed to federal funding of the Union Station re-development. This commitment was withdrawn by Hon. Jean-Luc Pepin who became Minister after the February 1980 General Election.

6. Conclusions

The foregoing notes indicate two characteristics of Ontario Rail Policy during the period which has been reviewed:

1. Its consistency, from the time of the Submission to the MacPherson Commission in 1960 to the present day; and,

2. The fact that this policy has been almost entirely reactive to federal initiatives.

It is this second point which has given rise to the formation of the Ontario Task Force on Provincial Rail Policy. The intent of this Task Force was described by the Minister of Transportation and Communications during the debate on the Ministry's 1980/81 Estimates:

- "Another way to ensure that the economy gets a leg up is to determine how to best use all the transportation tools available. Here, staff studies have indicated that we should take a long, hard look at both the Great Lakes-Seaway system and the rail network which sustain our manufacturing, mining, logging and industrial heartlands. This will be done at a time when the cost and availability of oil-related energy could be a major strain on the Ontario economy."

- "As you all know, the other task force has been created under the chairmanship of Margaret Scrivener to review the potential of rail transport in the Province. One is complementary to the other, and both have virtually the same mandate, to ensure that both systems work to our best advantage."

- "The possible electrification of the GO train system demands the Ministry's consideration. I must add, the fact that we can even consider such an initiative reflects the value of Ontario's investment in electrical generating capacity."

(See Note 6.1)

As stated in the introduction, the area of research for this paper has been limited, both by the time available and by the need to restrict sources to public documents and pronouncements.

In order to be comprehensive, research should be extended into the whole body of proceedings of the Legislature back to whatever date is considered appropriate.

APPENDIX I

STATEMENT IN THE LEGISLATURE BY

HONOURABLE JAMES SNOW

MINISTER'S UPCOMING MEETING

WITH OTTO LANG

Monday, June 14, 1976

MR. SPEAKER:

AS THE MEMBERS OF THIS HOUSE MAY OR MAY NOT BE AWARE, I AM SCHEDULED TO MEET WITH THE FEDERAL MINISTER OF TRANSPORT CANADA, THE HONOURABLE OTTO LANG, ON THE 29TH OF THIS MONTH.

AMONG THE SEVERAL ITEMS ON OUR AGENDA WILL BE MY MINISTRY'S CONCERNS IN THE AREA OF RAIL TRANSPORTATION IN THIS PROVINCE.

SPECIFICALLY, I AM DETERMINED TO OBTAIN A CLEAR UNDERSTANDING OF THE FEDERAL GOVERNMENT'S POSITION VIS A VIS THE FUTURE OF THE WINDSOR-TO-TORONTO CORRIDOR.

AT THE SAME TIME I SHALL ADVISE THE MINISTER OF THE IMPORTANCE ONTARIO PLACES ON RAIL PASSENGER SERVICE AS WELL AS THE POSITION MY OFFICIALS WILL BE TAKING AT THE CANADIAN TRANSPORT COMMISSION'S HEARINGS IN OTTAWA COMMENCING AT THE END OF THE MONTH. THE LATTER, OF COURSE, FOCUSES ON THE RATIONALIZATION OF THE CN-CP TRANSCONTINENTAL RAIL PASSENGER SERVICES.

I ALSO INTEND TO MAKE MR. LANG FULLY AWARE OF THE CONCERNS I'M SURE ALL THE MEMBERS OF THIS HOUSE SHARE, REGARDING RAIL SERVICE TO ONTARIO'S NORTH AND NORTHEAST WHERE, OF COURSE, WE ARE DIRECTLY INVOLVED THROUGH THE ONTARIO NORTHLAND TRANSPORTATION COMMISSION.

I DON'T BELIEVE I HAVE TO ELABORATE ON THE QUESTION OF ONTARIO'S STANCE IN THE MATTER OF THE WINDSOR-TO-TORONTO CORRIDOR.

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LAST MAY 20TH IN THIS HOUSE, I RESPONDED TO MR. LANG'S TELEGRAM IN WHICH HE OUTLINED THAT THE FIRST PHASE OF PLANS TO IMPROVE THE QUEBEC CITY-TO-WINDSOR RAIL CORRIDOR WOULD INITIALLY, AT LEAST, INCLUDE ONLY THE QUEBEC CITY-TO-MONTREAL SEGMENT.

AT THAT TIME I POINTED OUT THAT THE FEDERAL GOVERNMENT'S DECISION TO LEAVE THE TORONTO-TO-WINDSOR CORRIDOR UNTIL -- AND I AGAIN QUOTE FROM MR. LANG'S TELEGRAM -- THE NEAR FUTURE -- END OF QUOTE -- IGNORED THE BASIC FACT THAT THE TORONTO-WINDSOR SEGMENT SERVES THE MOST DENSELY POPULATED AREA IN CANADA. IT WAS, I REMINDED HIM, ALSO THE AREA WITH THE HIGHEST ECONOMIC POTENTIAL.

AND I CONCLUDED BY SAYING THAT I WAS MOST DISAPPOINTED; THAT I WOULD ASK FOR A MINISTER-TO-MINISTER MEETING AT THE EARLIEST POSSIBLE MOMENT. THAT MEETING, AS I NOTED EARLIER, IS SCHEDULED FOR THE 29TH OF THIS MONTH.

IN THE MATTER OF THE CTC'S ECONOMIC RATIONALIZATION HEARING ON THE CN AND CP TRANS CONTINENTAL PASSENGER RAIL SERVICES, I SHALL INFORM MR. LANG THAT ONTARIO SUPPORTS IN THEORY THE PRINCIPLE OF SUCH RATIONALIZATION. THIS IS ON THE ASSUMPTION, HOWEVER, THAT RATIONALIZATION DOES NOT INVOLVE THE TRANSFER OF FINANCIAL RESPONSIBILITY OF REPLACEMENT SERVICES TO THE PROVINCE OF ONTARIO

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NOR WILL OUR SUPPORT IMPLY ACCEPTANCE SHOULD THERE BE DISCONTINUANCE OF PORTIONS OF THE TRANSCONTINENTAL WHICH CURRENTLY PROVIDE AN ESSENTIAL SERVICE TO OUR NORTHERN COMMUNITIES.

I SHALL INSIST THAT SHOULD THE CTC RULE IN FAVOUR OF DISCONTINUANCE IN SUCH AREAS, THESE SERVICES MUST BE REPLACED BY LOCAL RAIL OR ACCEPTABLE ALTERNATE SERVICES TAILORED TO FIT THE AFFECTED COMMUNITIES' NEEDS.

DECISIONS ARISING FROM THE TRANSCONTINENTAL RATIONALIZATION HEARINGS COULD POSSIBLY HAVE AN EFFECT ON THE OPERATIONS OF THE ONR AS WELL.

AND I SHALL AGAIN MAKE THE MINISTER OF TRANSPORT CANADA AWARE OF SUCH POSSIBILITIES.

FOR EXAMPLE, SHOULD THERE BE A RECONFIGURATION OF THE TRANSCONTINENTAL RAIL ROUTE THROUGH ONTARIO, IT COULD INCLUDE THE TORONTO-TO-NORTH BAY LINK WHICH ONR OPERATES WITH CN ON A POOLED EQUIPMENT BASIS.

THUS, SHOULD THIS KIND OF RECONFIGURATION RESULT, IT WOULD INSIST THAT ONR AND CN EQUIPMENT BE COMPATIBLE.

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I SHALL THEREFORE ASK MR. LANG TO MAKE ME FULLY AWARE OF THE FEDERAL POSITION IN THIS AREA AS SOON AS POSSIBLE.

I SHALL STRESS THE FACT THAT THE ONTARIO GOVERNMENT RE-AFFIRMS ITS PREVIOUSLY STATED POSITION TO IMPROVE RAIL PASSENGER SERVICE INTO THE NORTH AND NORTHEAST AREAS OF THE PROVINCE.

SUCH SERVICES CAN ONLY BE CONSIDERED IN THEIR TOTALITY -- FROM TORONTO-TO-COCHRANE AND BEYOND; THE BRANCH LINES TO MOOSONEE, NORANDA AND TIMMINS. YET -- AND I SHALL POINT THIS OUT EMPHATICALLY TO MR. LANG -- THE TORONTO-TO-NORTH BAY, AS WELL AS OTHER CORRIDORS, IS THE RESPONSIBILITY OF THE CN -- WITH ITS ATTENDANT FEDERAL FUNDING.

THUS, REGARDLESS OF OUR RESOLUTION, ANY ACTION TAKEN TO UPGRADE THE ONR'S SERVICES MUST BE CO-ORDINATED WITH THE FEDERAL GOVERNMENT AND THE CNR.

ADDRESSING THIS PROBLEM HAS NOT BEEN EASY. THEREFORE, I SHALL ASK THE MINISTER OF TRANSPORT CANADA TO CLEARLY STATE HIS POSITION ON THE POINTS I HAVE RAISED IN PREVIOUS CORRESPONDENCE.

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FIRSTLY WILL BE THE MATTER OF MANDATORY DISCONTINUANCE HEARINGS. IN THIS AREA IT WOULD BE RATHER FOOLISH OF THE PROVINCE TO MAKE LARGE CAPITAL INVESTMENTS FOR NEW EQUIPMENT WHILE THE THREAT OF A FEDERAL DISCONTINUANCE HEARING EXISTS.

HENCE, I SHALL ASK FOR EITHER A FIVE-YEAR DEFERRAL OF THE PASSENGER SERVICE DISCONTINUANCE HEARING ON CN CORRIDORS TO ENABLE US TO MOVE AHEAD -- OR HOLD THE NECESSARY HEARING IMMEDIATELY.

SECONDLY, I WILL ASK FOR ASSURANCES THAT FEDERAL FUNDING BE CONTINUED ON THE TORONTO-NORTH BAY PASSENGER RUN.

THIRDLY, I SHALL REQUEST THAT THE CTC APPROVE FEDERAL SUBSIDIES FOR ONR PASSENGER SERVICE DEFICITS ON THE SAME BASIS AS THOSE PROVIDED THE CN PORTIONS.

ON THIS SUBJECT, WHILE THE ONR DOES NOT OPERATE UNDER A FEDERAL CHARTER, THERE IS PLENTY OF ROOM FOR CONSIDERING A REQUEST FOR SUBSIDIES. THE ONR DOES, IN FACT, SERVE MANY REMOTE NORTHERN ONTARIO COMMUNITIES AND, IF I MAY QUOTE MR. LANG HIMSELF IN A DIRECTIVE DATED JANUARY 29TH OF THIS YEAR: QUOTE -- RAIL PASSENGER SERVICE SHOULD <u>NOT</u> BE ABANDONED IN <u>ANY</u> CASE WHERE NO OTHER COMMERCIAL SERVICE EXISTS. -- END OF QUOTE.

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THAT, I SHALL ARGUE, OFFERS JUSTIFICATION FOR FEDERAL FUNDING FOR THE ONR.

AS FOR OUR COMMITMENTS TO PROVIDE THE NORTH AND NORTHEAST WITH UPGRADED AND IMPROVED SERVICES, I SHALL MAKE IT ABUNDANTLY CLEAR THAT THE UNCERTAINTIES CONCERNING FUNDING, DISCONTINUANCE HEARINGS, TRANSCONTINENTAL RATIONALIZATION AND EQUIPMENT NEEDS ARE SERIOUSLY IMPAIRING THIS GOVERNMENT'S ABILITY TO REACH ANY REAL AND MEANINGFUL DECISIONS IN RAIL TRANSPORTATION TO THE NORTH AND NORTHEASTERN AREAS OF THIS PROVINCE.

THEREFORE, THE TIME HAS COME FOR ACTION -- IF WE ARE TO RESPOND TO THE GENUINE DESIRES AND NEEDS OF PEOPLE RESIDENT IN THE NORTH AND NORTHEAST. TO THIS END, IT IS THE <u>FIRM</u> INTENTION OF THE GOVERNMENT OF ONTARIO TO ADOPT A NEW EQUIPMENT SCHEDULE WHICH WILL ALLOW US TO ORDER THREE LATE MODEL TRAINS ANYTIME BEFORE THE END OF THIS YEAR.

TO ACCOMPLISH THIS WE SHALL CONTINUE NEGOTIATIONS WITH AMTRAK, REQUESTING THAT OUR OPTIONS TO ACQUIRE THREE TURBOS BE EXTENDED UNTIL THE END OF 1976. AT THE SAME TIME, WE SHALL FOLLOW WITH MORE THAN CONSIDERABLE INTEREST THE KIND OF NEW EQUIPMENT

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SCHEDULED FOR DELIVERY FOR THE QUEBEC CITY-MONTREAL PROJECT I REFERRED TO EARLIER. TENDERS FOR THIS NEW EQUIPMENT WILL, I AM TOLD, BE OPENED SOMETIME IN DECEMBER.

AT THE SAME TIME I HAVE INSTRUCTED THE GENERAL MANAGER OF THE ONTARIO NORTHLAND TRANSPORTATION COMMISSION, MR. F. S. CLIFFORD, TO IMMEDIATELY BEGIN SHORT-TERM IMPROVEMENTS TO OUR EXISTING SERVICES -- SUCH AS THE IMPROVING OF THE QUALITY OF SERVICE BY ANY MEANS NECESSARY: BY RE-ASSESSING SCHEDULES AND OPERATIONAL REQUIREMENTS AND UPGRADING ALL EQUIPMENT. MR. CLIFFORD WILL ALSO MEET WITH THE CNR TO ACTIVELY DISCUSS THE RATIONALIZATION OF THE OPERATIONAL REQUIREMENTS TO MEET THIS OBJECTIVE.

THANK YOU.

APPENDIX II

STATEMENT IN THE LEGISLATURE BY

HONOURABLE JAMES SNOW

MINISTER OF TRANSPORTATION AND COMMUNICATIONS

MINISTER'S RESPONSE TO OTTO LANG'S TELEGRAM

RE THE QUEBEC CITY - WINDSOR CORRIDOR

THURSDAY, MAY 20, 1976

MR. SPEAKER:

I HAVE JUST RECEIVED A TELEGRAM TODAY FROM THE HONOURABLE OTTO LANG, MINISTER OF TRANSPORT, WHICH READS AS FOLLOWS, AND I QUOTE:

"IN MY STATEMENT IN THE HOUSE OF COMMONS, JANUARY 29TH LAST, I INDICATED THAT I WOULD ANNOUNCE IN THE NEAR FUTURE PLANS TO IMPROVE RAILWAY PASSENGER SERVICE IN QUEBEC CITY - WINDSOR CORRIDOR.

"FOR YOUR ADVANCE INFORMATION AN ANNOUNCEMENT WILL BE MADE SHORTLY TO THE EFFECT THAT AS A FIRST STEP THE QUEBEC-MONTREAL SECTION OF THE CORRIDOR WILL BE DEVELOPED WITH APPROXIMATELY $30-M BEING <u>SPENT OVER THE NEXT THREE YEARS</u>. CP RAIL WILL OPERATE THE SERVICE ON THIS ROUTE. THIS MONEY WILL BE SPENT ON ITEMS SUCH AS ACQUIRING NEW MODERN TRAINS, STRAIGHTENING CURVES, LAYING HEAVIER RAIL, IMPROVING SIGNALS AND MAINTENANCE FACILITIES, ETC.

"I WOULD LIKE TO CONSIDER THIS ANNOUNCEMENT AS A FIRST STEP TOWARDS A GRADUAL IMPROVEMENT THROUGHOUT THE CORRIDOR.

"I HOPE TO BE IN A POSITION TO MAKE A SIMILAR ANNOUNCEMENT ABOUT THE TORONTO-WINDSOR SECTION IN THE NEAR FUTURE.

"I WOULD ALSO LIKE TO THANK YOUR OFFICIALS WHO HAVE CONTRIBUTED TO THE WORK DONE SO FAR AND I WOULD APPRECIATE YOUR CONTINUED CO-OPERATION SO THAT OUR EFFORTS CAN BEAR RESULTS IN THE NEAR FUTURE. OTTO LANG (END OF QUOTES.)

... 2

THIS STATEMENT OF MR. LANG'S, INDICATING OTTAWA'S INTENT TO DETERMINE THE IMPACT OF MODERN HIGH SPEED RAIL SERVICE BETWEEN QUEBEC CITY AND MONTREAL HAS LEFT ME, TO SAY THE LEAST, DISAPPOINTED.

AS RECENTLY AS JANUARY 29TH AS MR. LANG HIMSELF NOTED, HE PUBLICLY STATED THAT HIS GOVERNMENT HAD RE-AFFIRMED AN EARLIER APPROVED-IN-PRINCIPLE REFERENCE TO FORMER MINISTER JEAN MARCHAND'S MAJOR STATEMENT ON NATIONAL TRANSPORTATION POLICY -- THAT THE FEDERAL GOVERNMENT WAS PREPARED TO CARRY OUT A DEMONSTRATION PROJECT TO DETERMINE THE FEASIBILITY AND IMPACT OF FREQUENT, HIGH-SPEED RUNS IN A QUEBEC-WINDSOR CORRIDOR.

AT THAT TIME, MR. LANG STATED EMPHATICALLY THAT HIS MINISTRY HAD ALREADY BEGUN DISCUSSIONS ON POTENTIAL IMPROVEMENTS WITH ONTARIO AND QUEBEC AND THE CARRIERS. HE ADDED THEN THAT HE HOPED TO ANNOUNCE SHORTLY, THE DETAILS OF THE PLAN WHICH WOULD SEE NEW EQUIPMENT OPERATING AT HIGHER STANDARDS BY 1979.

THESE FEDERAL INITIATIVES WERE GREETED WITH CONSIDERABLE ENTHUSIASM BY MY MINISTRY -- BECAUSE WE, TOO, RECOGNIZED THE OPPORTUNITIES THAT EXISTED, PARTICULARLY IN THE TORONTO-WINDSOR SEGMENT OF THE CORRIDOR. AND WE FELT THAT, AS A RESULT OF THE PROPER INTEGRATION OF NEW PASSENGER TRANSPORTATION MODES, WE COULD TIE AN EFFICIENT AND ECONOMIC PASSENGER SYSTEM SERVING ALL THE WESTERN COUNTIES.

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In addition, this potential re-assessment of passenger transportation would have permitted us to redress the problems created by the discontinuance of rail services in the Grey-Bruce area in 1970.

Now, today, we have been told that the initial efforts will only include the Montreal-to-Quebec City corridor.

Mr. Lang's statement, flying in the teeth of the fact that the Toronto-Windsor segment serves the densest populated area with the highest economic potential along the entire length of the originally proposed corridor, as I stated earlier, leaves me very disappointed.

In my dealings with Mr. Lang, I have found him to be co-operative. He also appeared to be truly interested in pursuing improvement in this very important section of the corridor. Therefore, I can only interpret his telegram to mean that the same enthusiasm was not shared by his colleagues in the Federal Cabinet.

Although Mr. Lang refers to his hope for future improvements in the Toronto-Windsor section, it appears it has been excluded from receiving any special assistance until the completion of the Montreal-Quebec City link.

Up until this sudden announcement, we in my Ministry have been under the impression that, in this particular area, we were working hand-in-hand with the Ministry of Transport, searching for a common answer to what is a common problem -- the lack of a modern, high-speed passenger

MODE WHICH BY 1979 OR EVEN 1980 WOULD BE IN MOTION TO COUNTERACT THE POTENTIAL EFFECTS OF ANY ENERGY SHORTFALLS.

WE HAD FELT THAT THE ORIGINAL DEMONSTRATION PROJECT -- COVERING THE QUEBEC CITY-TO-WINDSOR CORRIDOR -- WAS OF PRIME IMPORTANCE TO BOTH GOVERNMENTS; THAT ULTIMATELY THE RESULTS COULD DETERMINE THE DIRECTION GOVERNMENT INVESTMENT IN PUBLIC TRANSPORTATION WOULD TAKE.

FOR THIS REASON, ALONE, I CANNOT UNDERSTAND OTTAWA'S ACTION AT THIS LATE MOMENT.

IN LIGHT OF WHAT I HAVE REVEALED, I CAN TELL THIS HOUSE THAT IT IS MY INTENTION TO ASK MR. LANG FOR A MINISTER-TO-MINISTER MEETING AS SOON AS IT CAN POSSIBLY BE ARRANGED.

AND I SHALL ASK THE MINISTER OF TRANSPORT TO RECONSIDER HIS DECISION -- TO DEFINE WHAT HE MEANT WHEN HE SAID HE HOPED TO MAKE AN ANNOUNCEMENT IN THE NEAR FUTURE ON THE TORONTO-WINDSOR SECTION. DOES THE NEAR FUTURE MEAN AT THE COMPLETION OF THE QUEBEC CITY TO MONTREAL PROJECT? OR DOES IT MEAN WITHIN THE NEXT FEW MONTHS?

THANK YOU.

Appendix III

Notes

Sources and Dates

1. Introduction

   1.1 Submission of Province of Ontario to the Royal Commission on Transportation - March 14, 1960 - page 5.

2. MacPherson Commission

   2.1 Submission of Province of Ontario to the Royal Commission on Transportation - March 14, 1960 - page 27.

   2.2 Ibid page 14

   2.3 Ibid page 2

   2.4 Ibid page 3

   2.5 Ibid page 3

   2.6 Ibid page 24

   2.7 Ibid page 4

   2.8 Ibid page 5

   2.9 Ibid page 21

   2.10 Ibid page 22

   2.11 Ibid page 22

   2.12 Ibid page 24

   2.13 Ibid page 27

STATEMENT IN THE LEGISLATURE BY

HONOURABLE JAMES SNOW

MINISTER'S UPCOMING MEETING

WITH OTTO LANG

Monday, June 14, 1976

3. National Transportation Act

3.1 National Transportation Act Section 3.

3.2 Western - rapeseed processes revised intervention of Government of Ontario January 29, 1972.

3.3 Anglo Canadian Pulp and Paper statement of position of Government of Ontario June 1972.

3.4 Statement in Legislature by Minister of Transportation and Communications May 02, 1975.

3.5 Press Release. Transport Canada "Highlights of Rail Passenger Policy Announcement by Transport Minister Otto Lang." January 29, 1976.

3.6 Minister of Transportation and Communications Press Release July 28, 1977.

3.7 Submission of the Government of the Province of Ontario to the House of Commons Standing Committee on Transport and Communications at its Hearing in South Western Ontario - 1972.

3.8 Hon. J.W. Snow, Minister of Transportation and Communications, Statement in the Legislature, April 04, 1977.

3.9 Hon. J.W. Snow, Minister of Transportation and Communications address June 14, 1977.

3.10 Hon. J.W. Snow, Minister of Transportation and Communications Statement in Legislature June 14, 1977.

3.11 Letter from Snow to Lang December 02, 1977.

3.12 Address by Hon. J.W. Snow, Minister of Transportation and Communications June 1977.

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3.14 Hon. J.W. Snow, Minister of Transportation and Communications Statement in Legislature, December 17, 1976.

3.15 Hon. J.W. Snow, Minister of Transportation and Communications Statement in Legislature October 31, 1977.

3.16 Hon. J.W. Snow, Minister of Transportation and Communications, address February 21, 1978.

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4. Ontario Northland Railway

4.1 Steam into Wilderness: Ontario Northland Railway 1902 - 1962 by Albert Tucker - Fitzhenry and Whiteside - Page 7.

4.2 Ibid page 7

4.3 Ibid page 74

4.4 Ibid page 95

4.5 Ibid page 98

4.6 Hon. W.G. Davis, Premier of Ontario. Address in Sudbury June 01, 1977.

5. Commuter Rail Transit

5.1 Metropolitan Toronto and Region Transportation Study --- third report of Technical Advisory Committee (November 1967).

5.2 Brief to Metropolitan Toronto and Regional Transportation Study from Standpoint of Canadian National Railway - February 19, 1963 page 1.

5.3 Report of Consultant on Committee Rail to Technical Advisory Committee of MTARTS - January 1965 page 9.

5.4 MTARTS -- Third report of Technical Advisory Committee (November 1967).

5.5. Design for Development: Toronto Centred Region - May 1970 page 21.

5.6 Design for Development Toronto Centred Region - August 1970 pages 9 and 10.

5.7 Toronto Centred Region Statement March 1976 pages 11 and 12.

5.8 MTC Press Release July 02, 1975.

5.9 Hon. J.W. Snow, Minister of Transportation and Communications Statement in Legislature December 17, 1976.

5.10 Ibid

5.11 Hon. J.W. Snow, Minister of Transportation and Communications Speech on March 01, 1977.

5.12 Hon. J.W. Snow, Minister of Transportation and Communications Speech on March 11, 1977.

5.13 Hon. J.W. Snow, Minister of Transportation and Communications Statement in Legislature, October 31,1977.

6. Conclusions

6.1 Legislature of Ontario Debates, Wednesday, April 30, 1980, pages R269/270.

T A X A T I O N   O F   R A I L W A Y S

Ministry of Revenue
Revenue and Operations Research Branch
June 30, 1980

TAXATION OF RAILWAYS

- Table of Contents -

T A X A T I O N   O F   R A I L W A Y S

Taxes on Motive Fuels

TAXATION OF RAILWAYS

1. TAXES ON MOTIVE FUELS

(a) Ontario Tax on Diesel Fuel

A general rate of 5.9 cents tax per litre under The Motor Vehicle Fuel Tax Act applies with respect to fuel used in all diesel-powered vehicles required to be licensed under the Highway Traffic Act. This application is the same for any commercial transportation company or any person operating diesel-powered highway vehicles. The off-highway use of diesel fuel, other than for that used in locomotives as described below, is not subject to tax.

Prior to April 11, 1979, Ontario did not tax the fuel used by railway diesel locomotives. As of that date, such fuel became taxable under The Motor Vehicle Fuel Tax Act, the rationale being that since other modes of commercial transportation (air, highway) were required to pay tax on motive fuels used, railways should do the same.

The rate of tax is 2.2 cents per litre and the revenue generated by this tax in its first year of application was $20.0 million.

(b) Federal Tax on Diesel Fuel

Under the Excise Tax Act (Canada), a rate of 9% on the producer's selling price applies to all diesel fuel for use in internal combustion engines. All diesel fuel purchased by railway companies, therefore, contains the same 9% tax component, regardless of whether used in internal combustion engines in their rail service operations, highway transport or other operations.

Prior to April, 1980 the tax rate on diesel fuel was 1.0 cents per litre. From that date, an ad valorem tax rate of 9% applies to the producers' selling prices of such fuels.

The fuel used in railway diesel locomotives is not exempt from the sales tax on petroleum products under the Excise Tax Act (Canada).

In the year ended March 31, 1980, there was an estimated $9.3 million federal sales tax included in the prices paid by the railway companies for the diesel locomotive fuel used in their Ontario rail service operations.

The additional excise tax of 1.5 cents a litre under the Excise Tax Act (Canada) applies only to gasoline and aviation gasoline and not to diesel fuel.

(c) Ontario Tax on Gasoline

The tax on gasoline of 4.6 cents a litre imposed under the Gasoline Tax Act applies to all gasoline sold in Ontario but railway companies and all other commercial concerns may claim a refund for the tax paid on gasoline used for purposes other than operating vehicles required to be licensed under the Highway Traffic Act. A tax on aviation fuel of 1.32 cents per litre is also imposed under this Act.

Railway companies bear the burden of these taxes to the same extent as other commercial concerns and there are no specific variations accorded them in the tax base.

(d) Federal Tax on Gasoline

Under the Excise Tax Act (Canada), a sales tax at the rate of 9% applies to the producer's selling price of all gasoline purchased by railroads and all other persons. Unlike Ontario, tax refunds are not made with respect to gasoline used for purposes other than to propel vehicles required to be licensed for highway use.

The additional excise tax of 1.5 cents a litre on gasoline and aviation gasoline does not apply to railroads or other commercial users.

These two federal taxes on gasoline apply to railroads in the same manner as to other gasoline users and there are no specific variations accorded them in the tax bases.

T A X A T I O N   O F   R A I L W A Y S

Taxes on Personal Property Other Than Motor Fuels

(Sales Taxes)

TAXATION OF RAILWAYS

2. TAXES ON PERSONAL PROPERTY OTHER THAN MOTIVE FUELS

(a) Ontario Tax on Personal Property

Under the Retail Sales Tax Act, railways pay tax on their purchases of goods and services at the same rates and are eligible for the same general exemptions as are other Ontario purchasers.

However, prior to March 8, 1978, railway rolling stock including locomotives was exempt from tax. Since that date it has been taxable on the basis of the proportion of distance travelled in Ontario to the total distance travelled. The rationale, per the budget address, was to align Ontario's tax treatment with the four other provinces then taxing such rolling stock and to raise revenues.

In the 1979/80 year, Ontario's sales tax paid by the railway companies on their purchases and leases of railroad rolling stock amounted to $15.0 million.

(b) Federal Tax on Personal Property

Goods purchased by railroads are subject to the same general sales tax of 9% on the manufacturers' selling prices (Excise Tax Act (Canada)) as are the goods of other purchasers.

Since 1974, however, the Excise Tax Act (Canada) has provided exemption for commercial transportation equipment used in the various transport modes; i.e., air, sea, highway, and rail. By reason of this exemption, railway locomotives and rolling stock, which constitute the major items of rail transportation costs, are no longer subject to federal sales tax.

T A X A T I O N   O F   R A I L W A Y S

Taxes on Real Property

TAXATION OF RAILWAYS

3. TAXES ON REAL PROPERTY

The Assessment Act (Ontario) and The Provincial Land Tax Act (Ontario)

Almost from their inception, railway properties have been treated differently for assessment and taxation purposes by the Province. This is, no doubt, due to the unique types of property railway companies own and the special arrangements they are required to make in order to function. Moreover, the railways have the added responsibility of working under strict Federal Government regulations which sometimes require them to operate lines at a loss in order to serve the greater goal of the public good.

Even as far back as 1853, railway properties were singled out for special treatment. Assessors had the right to require property holders to file an annual return setting out the value of their real property holdings. This provision was assigned to the railway companies by statute and the companies were expected to differentiate between the rights of way and all other real property. Assessors were to draw the same distinction in placing their valuations on railway property. With some exceptions, the distinction is made to the present day.

Other distinctions have been added. The 1904 Assessment Act introduced the additional classification of vacant lands; exempted railways from business assessment; and inaugurated the concept of assessing rateable machinery at the "actual cash value as the same would be appraised upon a sale to another company possessing similar conditions and burdens ...". The assessment provisions of the 1904 Act are by and large reflected in the current Act. Of course, guidance from the courts has been given to assessors with respect to the manner in which these provisions are to be interpreted.

Section 38(2) of The Assessment Act R.S.O. 1970, c. 32, specifies four classes of property for assessment purposes as well as the standards of assessments related to each class:

(a) the roadway or right of way at the value at which lands are assessed in the immediate vicinity, but not including the structures, substructures and superstructures, rails, ties, poles and other property thereon;

- 5 -

(b) the vacant land, at its value as other vacant lands are assessed under this Act;

(c) the structures, substructures, superstructures, rails, ties, poles and other property belonging to or used by the company (not including rolling stock and not including tunnels or bridges in, over, under or forming part of any highway, street or road merely crossed by the line of railway) at their actual cash value as they would be appraised upon a sale to another company possessing similar powers, rights and franchises, regard being had to all circumstances adversely affecting the value including the non-user of such property;

(d) the real property not designated in clauses a, b and c in actual use and occupation by the company, at its actual cash value as it would be appraised upon a sale to another company possessing similar powers, rights and franchises.

Rails, ties, poles, wires, structures, substructures and superstructures used exclusively for railway purposes (except stations, freight sheds, offices, warehouses, elevators, hotels, heating plants, round houses and machine, repair and other shops) are not liable to assessment.

As far as unorganized territories are concerned, rights of way are "assessed at the actual value thereof according to the average value of land in the locality". (The Provincial Land Tax Act R.S.O. 1970, c. 370, s. 12). All other valuation provisions are similar to The Assessment Act. What does present difficulties for assessors and railway companies is the valuation of railway rights of way. According to the legislation, the roadway or right of way is to be assessed "at the value at which lands are assessed in the immediate vicinity". The problem arises in that roadways or rights of way are valued according to the values of surrounding lands, not on their intrinsic values. In urban areas, where the surrounding lands are generally worth much more than agricultural and forested lands, assessments on railway rights of way increase accordingly. The difficulty for the railroads would be even further exacerbated if market value assessments were implemented. Under the current assessment systems in place in most municipalities land tends to be undervalued. Market value or a modified market value system under the Section 86 Program would greatly increase the assessed values of rights of way, thereby adding that much more to the tax burdens of the railway companies.

The assessment of rights of way is a departure from the traditional 'ad valorem' standard of property assessment. The market for rights of way is severely limited due to the nature of the property. Few uses may be found for a piece of land one hundred feet wide (the width is prescribed by Federal legislation, railroad companies have stated that they need only twenty feet) and perhaps several miles long. Presumably, the land only would be useful as a railway right of way and the only parties interested in procuring a railway right of way for commercial purposes would be another railway.

Various commissions and studies, e.g. Budget Paper E (1976), Blair Commission (1977), Treasurer's White Paper (January, 1978) have advocated that railway rights of way be assessed on the basis of their market values. But there's the rub. How does the assessor value the one hundred foot swath through all classes of property without any reference to the surrounding lands? If he uses the surrounding lands, he is right back to the abutting land principle - a principle in many instances that defies the willing buyer, willing seller concept of market value. The answer begs the question.

The Province of British Columbia wrestled with the problem in the 1950's. In 1956, a number of decisions were handed down in British Columbia with respect to the market value of rights of way. The British Columbia Municipal Act of the day (s. 238(4)), provided that "any privately owned right-of-way shall be assessed in addition (to the miles of single track) and separately at its actual value as land". The British Columbia Assessment Appeal Board recognized the difficulty in assessing this type of property and said, "where assessment must be based upon actual value, it must, to a substantial extent, be arbitrary." (The Canadian Pacific Railway Company and the Assessor, Municipality of Burnaby, April 1956). The Board then proceeded to value the property using an arbitrary formula.

One can appreciate the difficulties which may arise from any formula used to value rights of way. The valuations of these properties to a large extent become arbitrary decisions on the part of the assessor. Indeed, the ratepayer's own estimate of value is arbitrary as well, for there are no standards available to judge one's estimates. It then becomes a matter for the courts to make arbitrary decisions on questions of this type and that based on no better evidence than either the ratepayer or the assessor has.

Railroads in general have little problem with the assessment of their properties at market value. The rights of way are still a bone of contention and will continue to be so until agreement is reached between municipalities, which want to protect their tax bases, and railroads, which are compelled to maintain rights of way, profitable or not.

Agreement may lie, perhaps, in making statutory provisions for the valuation of rights of way similar to pipelines (s. 33 of The Assessment Act). This section provides statutory rates for pipelines on a length times diameter basis. In the past, the railway companies have suggested statutory rates be used for right-of-way assessments based on classifications such as urban industrial, urban residential, rural, etc. with such rates to be examined at stated regular intervals. At least, there is the possibility of agreement between the parties in this approach. Municipal tax bases re the railway properties would be protected and the railroad companies themselves would not feel threatened by large tax increases in urban areas. Thus, any expansion plans would be facilitated.

The study done by Treasury and Economics to indicate the impact of market value on railway properties shows a net increase in 1976 property taxes of 62.5%. The property assessment system in place in 1976 yielded 13.6 million dollars for all municipalities across the Province. The proposed market value system, based on 1975 market values, would have yielded 22.1 million dollars.

Although Treasury does not have updated figures, it is suspected the increase would remain somewhat the same if market value was introduced; however, it is not known what impact new equalization and apportionment figures would have on railway properties.

T A X A T I O N   O F   R A I L W A Y S

Taxes on Corporations

(Income and Capital Taxes)

TAXATION OF RAILWAYS

4. TAXES ON CORPORATIONS

(a) Introduction

General:

Corporations that are resident in Canada or that carry on business in Canada are liable to pay the taxes imposed under the Income Tax Act (Canada). These taxes are collected and administered by the Department of National Revenue, Taxation (commonly called Revenue Canada, Taxation).

Corporations that carry on business through permanent establishments in Ontario are liable to pay the income and capital taxes imposed under The Corporations Tax Act. These taxes are collected and administered by the Ontario Ministry of Revenue.

Income Tax:

Insofar as the income tax rules are concerned, Ontario's taxation policy is to match the federal income tax policy except where Ontario maintains an independent policy. Insofar as the railroad industry is concerned there are no major policy differences in the federal and Ontario calculations of taxable income.

For the most part railway corporations are treated no differently than other corporations. The calculations of

- business income and losses
- property income and losses, and
- capital gains and losses

are basically the same for all corporations.

Here and there special accommodation to these rules has been made because of the special nature of the railroad industry. These special areas deal with

- deductions from income for the cost of railway assets
- allocation of taxable income to the other taxing jurisdictions in Canada

Once the tax base has been calculated and the tax rates applied, the federal and Ontario policies differ significantly

in their tax credit policies.

In 1978 the federal government extended the basic investment tax credit to transportation equipment. The railroad industry is a beneficiary of this tax incentive which it shares with other industries providing long-distance transport of freight and passengers. Ontario does not have a similar incentive for transportation equipment.

Until 1957 railroad corporations were exempt from Ontario corporations income tax provided that they paid a special Ontario tax on their investment in and use of railway assets in Ontario.

Capital tax:

From 1899 to 1973 railroad corporations, railway express companies and railway car companies were subject to special Ontario taxes on their investments in or use of railway assets.

Effective April 13, 1973 these corporations became liable to pay Ontario capital tax as ordinary corporations. This tax, which is payable in addition to the income tax, is based on the shareholders' equity and medium and long-term liabilities of a corporation.

Special accommodation has been made in order to allocate the taxable capital of railroad corporations to the other jurisdictions of Canada. The same formula is used to allocate both taxable income and taxable capital.

(b) Federal and Ontario taxes on income

Tax treatment of government assistance:

Because of its importance to Canada the railway industry has received substantial amounts of financial assistance from the federal and provincial governments. This financial assistance has been given out of a desire to

- promote the unification of Canada
- subsidize transportation in regions which need an economical means of transport
- prevent bankruptcy of railroad companies.

This section of the paper deals with the tax treatment of two types of government assistance

1. - government participation as Crown corporations
2. - government grants and subsidies.

1. Crown corporations

The federal government and several provincial governments have created corporations which own or operate railways. For example, the federal government owns

- Canadian National Railways
- VIA Rail

and the Ontario government has created the Ontario Northland Transportation Commission and the Toronto Area Transit Operating Authority which operate the Ontario Northland Railway and GO Rail respectively.

The federal and Ontario income tax legislation provide for a general exemption from tax of any corporation, commission or authority not less than 90% of the shares or capital of which is owned by Her Majesty in right of Canada or a province, or a wholly-owned subsidiary of such a Corporation. These corporations are commonly called "Crown corporations".

This general exemption does not apply to certain Crown corporations that have been specifically prescribed as being taxable. The federal Crown corporations that are taxable are those listed in Schedule D to the Financial Administration Act (Canada).

These taxable corporations include

- Canadian National Railways and its subsidiaries

  and

- VIA Rail.

These Crown corporations are liable to tax because they compete with privately owned corporations, such as Canadian Pacific Railway.

Because these federal Crown corporations are not agents of the Crown, these corporations may deduct from their federal tax payable an abatement of 10 per cent of their taxable income, with the result that the effective federal rate on taxable income earned by these corporations in Canada is 36 per cent. The purpose of the provincial tax abatement is to permit the provinces (and since 1978 territories) of Canada to impose corporations income taxes on these corporations.

At present the federal government exempts from income tax corporations owned by the provincial and municipal governments.

* * *

The Ontario policy is to tax federal Crown corporations if they are taxed at the federal level, but not to tax Ontario Crown corporations, in particular, Ontario Northland Transportation Commission and the Toronto Area Transport Operating Authority.

Under The Corporations Tax Act Crown corporations are generally exempt from income and capital tax; however this exemption does not apply in the case of

- Canadian National Railway

- VIA Rail

which are prescribed as taxable Crown corporations in the regulation published under that Act. These Crown corporations along with the other corporations operating railroads in Ontario are subject to

- corporations income tax - 14% of their taxable income earned in Ontario, and

- capital tax - 0.3% of their taxable capital used in Ontario.

2. Government grants and subsidies

Outlined in the table below are the general principles followed for the taxation of

- government grants and subsidies
- forgiveable loans
- deductions from tax
- investment allowances and
- other forms of government assistance to taxpayers.

Assistance	Purpose	Conditions	Tax treatment in the absence of legislation to the contrary
Grant or subsidy	to augment income	determined by an income deficiency	included in income of the recipient
Grant or subsidy	to reduce expenses	determined by specific expenses	reduces the recipient's deductible expenses
Grant or subsidy	to augment income or to reduce expense	not determined by income deficiency or specific expenses AND promotes some event or activity desired by the government	tax-exempt, that is, not included in income or does not reduce the recipient's deductible expenses
Grant or subsidy	to acquire a capital asset	determined by acquisition of property	does not increase income BUT reduces the cost of the asset for purpose of - deductions for the cost of a depreciable asset - capital gains/loss calculations

Assistance	Purpose	Conditions	Tax treatment in the absence of legislation to the contrary
Grant or subsidy	to acquire capital asset	not determined by acquisition of property AND promotes some desired event or activity	tax-exempt, that is, grant does not reduce cost of the asset
Forgiveable loans	to acquire a capital asset	receipt of loan determined by acquisition of property	reduces the cost of the asset when the taxpayer receives or becomes entitled to receive the loan
		re-payment of loan	increases the cost of the asset when repayment is made
Investment tax credits and allowances	to acquire a capital asset	determined by acquisition of property	reduces the cost of the asset when the tax credit is deducted from tax

For federal income tax purposes certain federal grants are specifically exempt because the Act which authorizes the grant provides that it be paid to the recipient exempt from tax. The Income Tax Act (Canada) recognizes all federal statutes that authorize tax exemptions, but it does not recognize tax exemptions in provincial statutes.

Payments made to augment the income of railway companies under the federal Atlantic Region Freight Assistance Act are added to their income for tax purposes because the payments are related to an income deficiency.

* * *

The Corporations Tax Act identifies the specific federal statutes which will also be exempt from Ontario corporations income tax.

The Ontario Act does not recognize any other Ontario statutes which may provide for tax exemptions.

Financial accounts:

A railway company may record the same transaction at least three different ways depending on who must have this information.

When reporting to its shareholders the railway company will record its assets, liabilities, shareholders' equity and results of its operations using generally accepted accounting principles which are applied consistently from year to year. In its shareholders' statements, the railway company reports

- the financial position and operating results for all its businesses, not just the railway business

- the consolidated financial position and operating results of the company and all its subsidiary companies.

When reporting to the Canadian Transport Commission, the railway company must record its financial position and operating results of only its railway business using a uniform classification of accounts and returns prescribed by that Commission pursuant to the Railway Act.

When reporting to the federal and Ontario taxing authorities the railway company and its subsidiaries must each submit its tax returns. Included in the tax returns are a set of financial statements of the company and a number of other schedules which reconcile the net income reported on its financial statements with its taxable income. The railway company will calculate its taxable income according to the provisions of the tax Acts.

Because different sets of rules apply the profits and losses reported to shareholders does not agree with those reported to the Canadian Transport Commission nor with those of the taxing authorities.

Set out below is a schedule showing the differences between book profits and taxable income for the railway industry.

	1976 $ millions	1977 $ millions
Book profits before taxes after adjustments to exclude intercorporate dividends, net capital gains and to deduct losses	$123.1	$163.9
Taxable income	122.3	144.0
Difference	$ .8	$ 19.9

Source: Statistics Canada. Corporation Taxation Statistics 1977. (Catalogue 61-208 Annual)

In the financial statements of a railway company there can be significant differences in the treatment of the amounts reported for railway assets such as railway track and grading, locomotives and rolling stock. Itemized below are some of the areas where there may be differences in the valuation of these assets:

- repairs and maintenance (an expense) vs. rebuilding and renovating
- the value of labour in assets built by railway employees
- the value of scrapped inventory
- profits and losses on disposals.

Because each version of the financial statements is prepared on a different basis and because the returns to the Canadian Transport Commission and the tax authorities are confidential documents, no direct comparison can be made of the differences.

Taxable Income

Railroad corporations are treated like other corporations for federal and Ontario income tax purposes; however there are some special provisions relating to the calculation of taxable income which apply to them directly or indirectly, these include

- deductions from business or property income for the cost of depreciable assets
- allocation of taxable income to jurisdictions in Canada.

<u>Deductions for the cost of depreciable assets</u>

Accounting principles for depreciation:

In their financial statements and reports to the Canadian Transport Commission railway companies deduct depreciation in calculating their operating profits or losses. Depreciation represents a decrease in value and reflects the estimated loss of fixed assets through use and obsolescence. Depreciation is calculated on the straight-line method by the Canadian Transport Commission in accordance with the group method and using rates that are authorized.

Depreciation under the straight-line method is calculated by dividing the cost of the asset by the estimated number of years of useful life. For example, for a diesel locomotive having an estimate useful life of 20 years, one-twentieth or 5 per cent of the cost would be written off each year for 20 years.

When depreciable property is retired or otherwise disposed of, the cost of the asset (less net salvage) is charged to accumulated depreciation in accordance with the group plan of depreciation.

Accounting principles for maintenance and repairs:

Routine maintenance and repairs are charged to expenses as incurred. Expenditures on major additions and replacements generally are capitalized with the exception of the following which are charged to expenses

- labour costs relating to track material replacements, and
- renewals of parts of railway assets where these do not constitute "major renewals" under the uniform classification of accounts.

Tax principles for depreciation:

Under the federal and Ontario tax Acts, taxpayers are not allowed to deduct from their income

- amounts for outlays, loss or replacement of capital, or

- allowances for depreciation or obsolescence.

unless such deductions are expressly provided for in the Act. This means that taxpayers are not allowed to deduct from their income for tax purposes, either the cost of buildings, machinery and equipment, etc., purchased or replaced in the year or the amount of depreciation charged as an expense.

For income tax purposes, taxpayers may deduct capital cost allowances from their business or property income. "Capital cost allowance" is the income tax term for depreciation that is calculated according to rules set out in the tax Acts and Regulations.

In the paragraphs that follow is an outline of the basic capital cost allowance system that has been in effect since 1949. In 1976 the rates under the system were modified, but the basic features of the system have remained unchanged since it was introduced.

When an asset is purchased its cost is recorded in the appropriate asset class prescribed in the income tax Regulations. The costs of all assets of that class are pooled, and a rate prescribed for that class will be applied in calculating the capital cost allowance for that class.

Capital cost allowances are calculated on the diminishing-balance method by which the maximum allowance is computed as a constant percentage of the undeducted cost. For example, a percentage of 10 per cent each year is applied to the undeducted cost of a railway locomotive. Under the capital cost allowance system greater allowances can be claimed in the early stages of the useful life of an asset and lesser allowances in the latter stages.

The rates prescribed in the regulations are the maximum rates that can be applied; taxpayers,if they choose, may claim at a lesser rate. The prescribed rates of the basic system reflect the estimated useful life of the assets in a class.

When an asset is retired, no adjustment is made to the asset class. If proceeds are receivable for the disposition of an asset, there is an adjustment to the undeducted costs

in the asset class. The undeducted costs are reduced by the lesser of the proceeds or the original cost of the asset. If the proceeds exceed the undeducted costs in the asset class, the excess is included in the taxpayer's income as "recaptured depreciation".

If the proceeds from the disposition of an asset exceeds the original cost of the asset, up to one-half of the excess will be taxed as a capital gain.

If all assets of a class are disposed of and the proceeds of disposition are less than the undeducted costs of the asset class the taxpayer may deduct from his business or property income the remaining undeducted costs in that class. The deduction is commonly called a "terminal loss".

Tax principles for repairs and maintenance:

Routine repairs and maintenance of depreciable assets are fully deductible from income. Expenditures on major replacements and renovations of assets may be capitalized if the renovation extends the useful life of the asset. The tax treatment for the expenditures on replacements and renovations is not necessarily the same as the accounting treatment.

In order to prevent differences in the accounting and tax treatment of repairs, replacements, alteration or renovation of railway assets, there is a special provision in the Income Tax Act. Railway companies are required to treat as depreciable assets any expenditures for repairs, replacements, etc. if these expenditures are not treated as expenses under the uniform classification of accounts of the Canadian Transport Commission.

Assets acquired before May 26, 1976:

The assets of a railway company have particularly long lives. Such a company may in 1980 be claiming capital cost allowances on assets that were acquired more than 25 years ago.

Set out below are the special rules for assets acquired by railway systems before May 26, 1976:

1. Cost of railway track acquired before 1956

2. Composite rate for assets acquired by a railway system before May 26, 1976.

1. Cost of railway track acquired before 1956

For purposes of calculating capital cost allowances, terminal losses and recaptured depreciation, the cost of

- railway track or railway track grading

- a railway crossing

acquired and owned by a taxpayer shall be deemed to be its net book value at the end of 1955.

This special provision may have been introduced to resolve the differences between the accounting and tax treatment of repairs, replacement, alteration or renovation of railway track and grading.

2. Composite rate for assets acquired by a railway system before May 26, 1976

A "railway system" as defined in the federal income tax Regulations "includes a railroad owned or operated by a common carrier, together with all buildings, rolling stock, equipment and other properties pertaining thereto ..."

Depreciable property that is a railway system or part thereof except the automotive equipment described below that was acquired before May 26, 1976 is depreciable at a maximum annual rate of 6 per cent.

Automotive equipment that is not designed to run on rails or track and that was acquired after the end of the taxpayer's 1958 taxation year is depreciable at a maximum annual rate of 30%.

The maximum rates presume an average useful life for these assets of 35 years and 7 years respectively.

The table below summarizes the rather simple classification for railway assets acquired before May 26, 1976.

Asset Class		Maximum rate	Average useful life
Railway system (Class 4)	- buildings, rolling stock, equipment and other property	6%	35 years
Automotive equipment (Class 10)	- cars and trucks	30%	7 years

Taxpayers other than railway companies, such as mining companies, financial leasing companies, that acquired railway assets and rolling stock before May 26, 1976 are able to use rates other than the 6 per cent composite rate in respect of that rolling stock.

Assets acquired after May 25, 1976:

Set out below are the special rules for assets acquired by railway companies after May 25, 1976:

1. Separate classes and rates for railway assets
2. Additional allowances for railway track and related property
3. Additional allowances for railway expansion and modernization.

1. Separate classes and rates for railway assets

Railway system assets acquired after May 25, 1976 are no longer subject to the composite rate of 6 per cent. They are now subject to the rate appropriate to each general type of asset, such as

- railway track and grading
- buildings
- diesel locomotives
- rolling stock
- other machinery and equipment, etc.

In 1976, the federal government after reviewing the capital cost allowance system decided that although the basic system operated efficiently the depreciation rates needed adjustment. In particular, the government decided that the composite rate was set too low for the assets currently used by railway companies.

The change to separate classes and rates for railway assets

- permits more flexibility for railway companies in calculating their capital cost allowance claims by increasing the number of classes and rates from 2 to 8 or more.

- permits more flexibility for the federal government to introduce tax incentives designed to encourage the modernization and re-equipping of the railroads.

- sets rates that better approximate the average useful lives of assets.

- eliminates the extreme differences in the rates for railway assets. Formerly different rates for the same assets applied depending on whether the assets were owned by railway companies or by other taxpayers.

- enhances the value of new railway assets in hands of railway companies.

Railway assets acquired by railway companies before May 26, 1976 continue to be depreciable for tax purposes at the maximum 6 per cent composite rate. Assets acquired after May 25, 1976 are depreciable at rates appropriate to the general type of the asset.

The table below demonstrates the effect of the reforms to the class and rate structure in 1976. Set out in Part e is a detailed listing of the regular rates applicable to assets acquired by railway companies after May 25, 1976.

The table below demonstrates the changes made to the basic rates for certain railway assets:

	Assets acquired before May 26, 1976		Assets acquired after May 25, 1976	
Assets	Rate	Estimated life	Rate	Estimated life
Railway track or grading acquired by				
- railway companies	6%	35 years)	1%	50 years
- other taxpayers*	1%	50 years)		
Automotive railway cars acquired by				
- railway companies	6%	35 years)	7%	30 years
- other taxpayers*	30%	7 years)		

- 22 -

Assets	Assets acquired before May 26, 1976 Rate	Estimated life	Assets acquired after May 25, 1976 Rate	Estimated life
Railway tank cars acquired by				
- railway companies	6%	35 years)	7%	30 years
- other taxpayers*	10%	20 years)		
Railroad locomotives acquired by				
- railway companies	6%	35 years)	10%	20 years
- other taxpayers*	20%	10 years)		
Other rolling stock acquired by				
- railway companies	6%	35 years)	7%	30 years
- other taxpayers*	20%	10 years)		

* Taxpayers other than railway companies often acquire railway assets, some for use in their business, such as mining, and others for leasing to other users, such as railway companies.

2. Additional allowances for railway track and related property

Taxpayers who, after March 31, 1977 and before April 1, 1980, acquire railway track or related property are eligible for additional depreciation allowances of

- 4 per cent of the undeducted cost of
  - railway track and grading
  - railway traffic control or signalling equipment, and
  - bridges, culverts, subways or tunnels ancillary to railway track and grading
- 3 per cent of the undeducted cost of trestles ancillary to railway track and grading.

The railway track and traffic control equipment eligible for these additional allowances includes

- railway track and grading, including components such as rails, ballast, ties and other track material

- railway traffic control or signalling equipment including switching, block signalling, interlocking, crossing protection, detection, speed control or retarding equipment but not including property that is primarily electronic data equipment (a computer) or systems software for the computer.

Set out below is a table showing the maximum regular, additional and combined rates that railway companies and other taxpayers except mining companies may apply to undeducted cost in calculating capital cost allowances for eligible assets:

Railway asset	Regular rate	Additional rate	Combined rate
Railway track or grading	4%	4%	8%
Railway traffic control or signalling equipment	4%	4%	8%
Bridges, culverts, subways or tunnels	4%	4%	8%
Trestles	5%	3%	8%

Assets acquired by railway companies after April 10, 1978 and before April 1, 1980 may be eligible for yet another additional allowance. Full details of this additional allowance are given in section 3 which follows.

The purpose of the additional allowance is to stimulate the replacement and extension of railway track by means of an income tax deferral. Instead of claiming capital cost allowances on the new railway track and property over a period of about 50 years the railway companies and taxpayers other than mining companies will be able to deduct the cost of these assets over a 25-year period.

* * *

Mining companies which acquire railway track and related property after March 31, 1977 may use a maximum basic rate of 30 per cent. These companies may also be eligible for a further capital cost allowance if their investment in railway track and related property is made in connection with the opening of a new mine or the major expansion of an existing mine and if the property is acquired before production from the new commences or before the expansion is completed.

3. Additional allowances for railway expansion and modernization

Taxpayers that own and operate a railway as common carriers may claim an additional allowance of 6% of the cost of certain railway assets acquired by them after April 10, 1978 and before 1983.

The additional allowance is a straight-line allowance based on the cost of the assets; however, the deduction of this allowance cannot exceed the undeducted cost of the railway assets. This straight-line allowance sharply reduces the period over which the cost of the assets can be deducted from a taxpayer's income.

Assets eligible for the additional write-off

- must be new when acquired
- must be acquired principally for use in Canada
- include such properties as
    - railway track and grading including components such as rails, ballast, ties, etc. (class 1 - regular rate 4%)
    - railway traffic control or signalling equipment including switching, block signalling, interlocking, crossing protection, detection, speed control or retarding equipment but not including computers or systems software (class 1 - regular rate 4%)
    - bridges, culverts, subways or tunnels that are ancillary to railway track and grading (class 1 - regular rate 4%)
    - trestles that are ancillary to railway track and grading (class 3 - regular rate 5%)
    - railway locomotives, but not automotive railway cars (class 6 - regular rate 10%)
    - machinery and equipment ancillary to
        - railway track and grading
        - railway traffic control or
        - signalling equipment described above
          (class 8 - regular rate 20%)

- machinery and equipment that is
  - acquired to maintain or service railway cars or locomotives
  - ancillary to or part of railway cars or locomotives
  (class 8 - regular rate 20%)

- property acquired principally for the purpose of gaining or producing income from a mine that is
  - railway track and grading
  - railway traffic control or signalling equipment
  - machinery and equipment ancillary to the first two properties described above
  - a bridge, culvert, subway, trestle or tunnel
  (class 10 - regular rate 30%)

- property acquired principally for the purpose of gaining income or producing income from
  - one or more mines operated by the taxpayer in Canada
  - that is a new mine or is a
  - major expansion of an existing mine and acquired before the coming into production of the new mine or the completion of the expansion of an existing mine that is

  - railway track and grading
  - railway traffic control or signalling equipment
  - machinery and equipment ancillary to the first two items described above
  - a bridge, culvert, subway, trestle or tunnel
  (class 28 - regular rate 30% plus an additional allowance which is fully deductible from income derived from the new mine or mine expansion)

- railway car
  (class 35 - regular rate 7%).

The additional allowance results in a deferral of the taxpayer's income tax liability. This deferral arises because the cost of railway assets is written off much faster than their estimated useful lives.

- 26 -

The table below indicates how the tax incentive reduces the normal write-off period of railway assets.

Railway asset	Estimated useful life (years)	Write-off period (years)	Reduction (years)
Railway track and grading and railway traffic control or signalling equipment	50	13	37
Railway locomotives	20	10	10
Railway cars	30	11	19
General railway machinery and equipment	10	7	3

The schedule below compares the regular allowance and the combined allowances for a new railway car that costs $100,000 and that is eligible for railway expansion and modernization

	Regular Allowance		Combined Allowance			
Taxation year	Undeducted cost	Allowance 7% of undeducted cost	Undeducted cost	Regular allowance 7% of undeducted cost	Additional allowance 6% of cost	Total
1980	$100,000	$7,000	$100,000	$7,000	$6,000	$13,000
1981	93,000	6,510	87,000	6,090	6,000	12,090
1982	86,490	6,054	74,910	5,244	6,000	11,244
1983	80,436	5,631	63,666	4,457	6,000	10,457
1984	74,805	5,236	53,209	3,725	6,000	9,725
1985	69,569	4,870	43,484	3,044	6,000	9,044
1986	64,699	4,529	34,440	2,411	6,000	8,411
1987	60,170	4,212	26,029	1,822	6,000	7,822
1988	55,958	3,917	18,207	1,275	6,000	7,275
1989	52,041	3,643	10,932	765	6,000	6,765
1990	48,398	3,388	4,167	292	3,875	4,167
1991	45,010	3,151	Nil	Nil	Nil	Nil
1992	etc.	etc.				

Special treatment for railway assets owned by taxpayers other than railway companies

Railway sidings:

If a taxpayer other than an operator of a railway system makes an expenditure pursuant to certain contracts with a railway system, that taxpayer may deduct from its income for tax purposes an allowance of up to 4 per cent of the undeducted amount of the expenditure.

To qualify for this allowance the expenditure must be made pursuant to a contract under which

- a railway siding is to be constructed to provide service to the taxpayer's place of business, and

- the railway siding does not become part of the taxpayer's property.

Mining companies:

The cost of certain railway assets acquired after March 31, 1977 for the purpose of gaining or producing income for a mine is depreciable at a maximum basic rate of 30 per cent of the undeducted cost of the assets.

Assets eligible for this special basic allowance include

- railway track and grading
- property ancillary to track and grading that is
  - railway traffic control or signalling equipment
  - a bridge, culvert, subway, trestle or tunnel
- machinery and equipment ancillary to the property mentioned above
- conveying and loading machinery and equipment (including structures) acquired for shipping output from a mine

but does not include rolling stock.

Certain railway assets acquired after April 10, 1978 and before 1983 for use in gaining mining income are eligible for the additional allowances for railway expansion and modernization of 6 per cent of cost.

Assets eligible for the regular allowance and the additional allowance for railway expansion and modernization include

- railway track and grading
- property ancillary to track and grading, such as railway traffic control or signalling equipment, bridges, culverts, subways, trestles and tunnels
- machinery and equipment ancillary to the property mentioned above.

* * *

If certain railway assets are acquired by a mining company in connection with the opening of a new mine after March 31, 1977 and before the new mine comes into commercial production or the mine expansion is completed the mining company may deduct

- the regular allowances (30% of undeducted cost) and the additional allowances described above from their business or property income, and
- an amount equalling the income from the new mine or mine expansion (not exceeding the undeducted cost of the assets).

This latter allowance, if claimed, provides for a maximum annual deduction for certain railway assets of up to 100% per cent of their cost.

* * *

Finally, the acquisition of certain railway assets in order to gain or produce income from a mine may permit the mining company to deduct for federal income tax purposes earned depletion allowances from its mining profits. The basic allowance is the lesser of $1. for every $3. of eligible expenditures or 25 per cent of mining profits. The Ontario Corporations Tax Act does not provide for the deduction of earned depletion allowances from mining profits; Ontario's allowances are automatically 33 1/3 per cent of the mining profits.

Additional depreciation for railway cars:

Taxpayers other than common carriers who own or operate a railway are entitled to claim an additional allowance on railway cars acquired after May 25, 1976 provided that the railway cars are owned by the taxpayers and are rented, leased or used by them in Canada during the taxation year.

The basic depreciation rate for railway cars is 7 per cent of the undeducted cost. This rate presumes an average useful life of about 30 years.

The rate for the additional write-off is 8 per cent of the undeducted cost. This additional rate when combined with the basic rate of 7 per cent permits the cost of a railway car to be almost completely written off over 13 years.

The purposes of the additional depreciation for railway cars are

- to encourage the modernization and re-equipping of Canadian rolling stock, and
- to stimulate the manufacture of rolling stock in Canada.

Allocation of taxable income and taxable capital:

General:

Under both the federal and Ontario tax Acts taxable income is calculated on a world-wide basis by corporations resident in Canada. Income tax is then calculated on the taxable income, and subsequently this tax is reduced by

- provincial tax abatements (federal income tax)
- allocations to other jurisdictions (Ontario income tax).

For the purpose of determining the amount of taxable income that is eligible for the 10 per cent provincial abatement and allocations to other jurisdictions, formulae are prescribed in the federal and Ontario tax regulations. These formulae are used by a corporation to allocate to each province or jurisdiction where it maintains a permanent establishment the taxable income earned in that province or jurisdiction.

For a province other than Ontario and Quebec (and Alberta after 1980 the taxable income earned in the province is the tax base for the provincial income tax. The tax rate applicable to the province is applied to the tax base, and this income tax is collected and administered by Revenue Canada on behalf of the province.

Ontario uses formulae similar to the federal formulae to allocate taxable income earned by a corporation to its permanent establishments outside Ontario. The amount that cannot be allocated to other jurisdictions is the Ontario taxable income to which the regular tax rate of 14 per cent is applied.

Railway corporations:

A special formula is used by a railway corporation in order to allocate the taxable income earned by its railway business. This formula, based on track mileage and railway traffic is as follows:

$$\frac{1}{2}\left(\frac{\text{Equated track miles in province}}{\text{Equated track miles in Canada}} + \frac{\text{Gross ton miles in a province}}{\text{Gross ton miles in Canada}}\right)$$

Some railway corporations operate other businesses, such as shipping, airlines, hotels, etc., in addition to their railway business. The taxable income derived by a railway corporation from its other business interests is deducted from its total taxable income in order to arrive at the taxable income from the railway business.

"Equated track miles" are:

- 100% of the distance of the railway corporation's first main track
- 80% of the distance to its other main tracks, and
- 50% of the distance of its yard tracks and sidings.

"Gross ton mile" is the number of short tons (metric tonnes) behind the locomotive moved one mile (kilometre) in freight or passenger trains in transportation service.

Ontario has converted its formula into metric measurements and uses the formula to allocate both taxable income earned and taxable capital used by a railway corporation to other jurisdictions in Canada.

Federal investment tax credit

Taxpayers may deduct from their federal income tax payable an investment credit for transportation equipment which they acquire after November 16, 1978. There is no termination date on the acquisition period for qualified transportation equipment.

The credit is 7 per cent of the cost of the qualified equipment.

The amount that can be deducted in any year cannot exceed the lesser of

- the investment credit at the end of the year (the current year's credit and unused credits for preceding years) and
- the total of
  - $15,000 and
  - one-half the amount by which the taxpayer's federal tax payable exceeds $15,000.

Unused credits may be carried forward indefinitely for deduction from federal income tax payable in future years.

If at the end of the 1980 taxation year a taxpayer has unused tax credits for transportation equipment of $350,000 and has a federal income tax liability of $300,000, the taxpayer may deduct a 1980 investment tax credit of $15,000 plus one-half of $285,000 or $157,500 and carry over to 1981 and future years unused credits totalling $192,500.

"Qualified transportation equipment" includes equipment prescribed in the federal income tax regulations that is used by railways, airlines, shipping companies, long-haul trucking and bussing businesses.

To be eligible for the federal investment tax credit, qualified transportation equipment that is railway equipment

- must be new when acquired by the taxpayer
- may be acquired by an operating railway company or by a taxpayer whose business is leasing property or lending money
- if acquired by a railway company must be acquired principally for the purpose of transporting passengers, property or passengers and property in Canada
- if acquired by an other taxpayer, must be leased by the taxpayer to a railway company. (The lessor must be a corporation that is a financial institution or a manufacturer of transportation equipment that sells or leases its products.)

Specially qualified transportation equipment includes the following railway assets:

- railway track and grading including components such as rail, ballast, etc.
- railway traffic control or signalling equipment but not including computers and systems software
- bridges, culverts, subways, trestles or tunnels ancillary to railway track or grading
- machinery and equipment ancillary to railway track or grading and railway traffic control or signalling equipment

- property similar to the above-mentioned property, if acquired for gaining or producing income from a mine

- property similar to the above-mentioned property if acquired for gaining or producing income from a new mine or major expansion of an existing mine

- railway locomotives, but not automotive railway cars

- railway cars

- machinery and equipment, that is, acquired principally for maintaining or servicing locomotives or railway cars or that is ancillary to or part of railway locomotives or railway cars.

* * *

If a taxpayer claims the federal investment tax credit for transportation equipment, the taxpayer must, for federal and Ontario income tax purposes, reduce the depreciable cost of the equipment. The cost is reduced because the taxpayer has received government assistance in purchasing the transportation equipment.

In the example above the taxpayer in 1980 acquired locomotives costing $5 million, and deducted an investment tax credit of $157,500. The depreciable cost of the locomotives of $4,842,500.

The purpose of this adjustment is to limit the deduction of depreciation allowances to the true cost to the taxpayer of the transportation equipment.

Ontario does not have an investment tax credit for transportation equipment; however, Ontario does require the downward adjustment of depreciable costs if a corporation claims the federal investment tax credit.

(c) Ontario Tax on Capital

From 1899 until 1973 railway corporations operating through permanent establishments in Ontario were subject to special annual taxes rather than the capital tax, and up until 1957 these corporations were subject to special taxes in lieu of income tax. The special tax of railway operators was a specific tax on track.

Set out in the table below are descriptions of the special taxes of railway companies in effect when the taxes were repealed on April 13, 1973.

Taxpayer	Tax rate	Tax base
Railway operator (Note: Lower rates applied to operators having up to 150 miles of track in Ontario)	$85 per mile	main track
		each additional track
	$60 per mile	- in municipalities of Ontario
	$40 per mile	- unorganized territories of Ontario
Railway express company	$800 for each 100 miles or fraction thereof (maximum $10,000)	miles of railway track used in Ontario
Railway car companies	1 per cent	money invested in sleeping, parlour or dining cars in Ontario

Commencing April 13, 1973 railway corporations became subject to the annual capital tax payable by other corporations having permanent establishments in Ontario.

The corporations capital tax is imposed, levied and collected by the province of Ontario. This tax is payable in addition to the corporations income tax.

The capital tax is an annual tax based on the taxable capital employed by the corporation in Ontario. For corporations resident in Canada taxable capital is

calculated on a world-wide basis as at the end of the corporation's fiscal year and consists of the following items:

- paid-up capital stock of the corporation
- all surpluses including retained earnings
- all reserves except those allowed as a deduction for income tax purposes
- loans and advances
    - from shareholders
    - from other corporations
- secured indebtedness

<u>less</u>

- allowances for goodwill, investments in corporations securities and government bonds and investments in mining assets (the last allowance has since April 6, 1976 been limited to deferred expenditures on mineral exploration in Canada).

After having calculated taxable capital, corporations determine the Ontario capital tax base by deducting from it the taxable capital used by them in other jurisdictions. The allocation formula used by railway corporations to allocate the taxable capital employed in their railway business has already been described.

At present Ontario maintains a multi-level capital tax rate structure, the rate which applies to a corporation depends on the nature of its business. Set out below is a table showing the tax rates that have been in effect after April 12, 1973 for most corporations.

Taxpayer	Rate	Period in effect
Corporations other than banks and loan and trust corporations	0.2%	From April 13, 1973 to April 19, 1977
	0.3%	After April 19, 1977

(d) Ontario Tax Revenues

Set out below are the Ontario corporations tax revenues reported by railway transport corporations for the 1975 to 1978 taxation years.

		Ontario Corporations Taxes (All dollar figures in thousands)					
Taxation	Number	Income tax		Capital tax		Total	
year	of taxpayers	Amount	No.	Amount	No.	Amount	No.
1975	71	$5,313	29	$2,223	71	$7,536	71
1976	61	4,775	26	3,319	61	8,094	61
1977	57	5,719	23	4,484	57	10,203	57
1978	56	6,287	27	4,993	56	11,280	56

Railway transport corporations pay approximately 1 per cent of Ontario's corporations tax revenues.

Tax rate changes

Income tax:

The general income tax rate in The Corporations Tax Act, 1972 increased in 1978 and again in 1979. Set out in the table below are the income tax rates that have been in effect under this Act.

Rate	Period in effect
12%	From January 1, 1972 to March 7, 1978
13%	From March 8, 1978 to April 10, 1979
14%	After April 11, 1979

Capital tax:

The general capital tax rate in The Corporations Tax Act, 1972 has increased twice since 1971. The table below sets out the capital tax rates that have been in effect under this Act.

Rate	Period in effect
0.1%	From January 1, 1972 to April 12, 1973
0.2%	From April 13, 1973 to April 19, 1977
0.3%	After April 19, 1977

The minimum capital tax payable under the Act is $50. This has remained unchanged since 1971.

(e) Regular Rates of Capital Cost Allowances on Assets Acquired By Railway Companies after May 25, 1976

Asset description	Rate	Class	Life
Air conditioning equipment (same rate as building, Class 3 or 6)			
Asphalt surface, storage yard	8%	17	25
Automobile	30%	10	7
Automotive equipment	30%	10	7
Automotive railway car	7%	35	30
Bridge	4%	1	50
Building,			
- brick, stone, cement, etc.	5%	3	40
- frame, log, galvanized or corrugated iron (no footings)	10%	6	20
Computer,			
- electronic data processing equipment (hardware)	30%	10	7
- systems software	30%	10	7
- computer software	100%	12	1
Culvert	4%	1	50
Electric wiring (same rate as building, Class 3 or 6)			

Asset description	Rate	Class	Life
Equipment not specifically mentioned	20%	8	10
Fence	10%	6	20
Furniture for other than aircraft or a ship	20%	8	10
Land	nil		
Lighting fixture (same rate as building, Class 3 or 6)			
Locomotive	10%	6	20
Machinery and equipment, not specifically mentioned	20%	8	10
Parking area	8%	17	25
Plumbing (same rate as building, Class 3 or 6)			
Radio communication equipment	20%	8	10
Railway car	7%	35	30
Railway siding	4%	1	50
Railway tank car	7%	35	30
Railway track or grading	4%	1	50

Asset description	Rate	Class	Life
Railway traffic control or signalling equipment	4%	1	50
Refrigeration equipment	20%	8	10
Right of way	nil		
Road	8%	17	25
Rolling stock	7%	35	30
Sidewalk	8%	17	25
Storage area, paved	8%	17	25
Storage tank, oil or water	10%	6	20
Subway or tunnel	4%	1	50
Tank car, railway	7%	35	30
Tool (under $200)	100%	12	1
Trestle	4%	1	50
Truck, automotive	30%	10	7
Tunnel or subway	4%	1	50
Water storage tank	10%	6	20
Wiring, electric (same rate as building, Class 3 or 6)			

5. POSSIBLE RAILWAY TAX CHANGES

Diesel Fuel:

(a) Reduce or eliminate the Ontario tax on diesel locomotive fuel levied under The Motor Fuel Tax Act.

(b) Urge the federal Government to do likewise with respect to the tax levied under The Excise Tax Act.

Tax on Personal Property (Sales Tax):

Reduce or eliminate the tax on railway rolling stock including locomotives.

Real Property:

Enact statutory provisions for the valuation of railway rights of way similar to those for pipelines.

Corporations (Income and Capital Taxes):

Income -

(a) Reduce tax rate

(b) Grant fast write-offs for railway assets used in Ontario

(c) Grant investment tax credit for railway assets used in Ontario

Capital -

(a) Reduce capital tax rate

(b) Repeal capital tax and restore special tax on railway assets used in Ontario

(c) Grant investment allowance for undeducted cost of railway assets

GOVERNMENT FINANCIAL SUPPORT FOR RAIL TRANSPORT

Ministry of Treasury and Economics
July, 1980

TABLE OF CONTENTS

The Task Force has asked this Ministry to provide it with some background perspective on government financial support for rail transport. We are pleased to respond with this Submission, which outlines some of the forms through which support can be channelled.

In undertaking this task, however, we have limited our efforts to an examination of the public record, which has been found to be both scattered and fragmentary. We have been unable to supplement this information by interviewing officials of either the railways or governmental bodies concerned with rail transport. Consequently, this Submission neither analyses the effects which various methods of support might have nor evaluates whether or not such effects may be desirable. What follows, then, is necessarily limited to a descriptive inventory of financial support mechanisms, in Canada and elsewhere.

I. FORMS OF GOVERNMENT SUPPORT FOR RAIL TRANSPORT

This section outlines the principal forms of government support. It goes on to sketch a common rationale for such support as well as some of the problems which it has raised.

GENERAL TYPES OF RAIL SUBSIDY Table 1

Operating Subsidy

EX ANTE

. usually, although not always, pertains to variable costs of operation
. estimated level of support or cost-sharing formula agreed upon in advance
. example: VIA contracts with Canadian National

EX POST

. compensates railroad, in whole or in part, for operating losses already incurred
. level of support forthcoming determined after extent of losses has been ascertained
. example: federal government compensation of railroads for the operation of "uneconomic" branch lines

Capital Subsidy

EX ANTE

. pertains to purchase of plant and equipment
. estimated level of support or cost-sharing formula agreed upon in advance
. example: federal government purchases of hopper cars on behalf of the Canadian Wheat Board

EX POST

. compensation for specified capital expenditures incurred
. example: in the United States, conditional grants for track up-grading on certain Amtrak lines

Experience suggests that each of the various forms of subsidy has some common drawbacks in application, although they contain no features which inherently lead to mis-use. For example, it has been widely noted that ex ante operating subsidies often prolong the life of "uneconomic" operations. It may also frequently be the case that the prospect of ex post operating subsidies may reduce incentives for innovation and the up-grading of services. Finally, it is not an uncommon view that ex ante capital subsidies may encourage "excessive" investment expenditures.

The vagueness of such terms as "uneconomic" and "excessive" follows from the common practice of not judging the desirability of rail transport assistance by strictly commercial criteria of profit and loss. In this view, it is felt that the complete range of social benefits that may be produced by rail subsidies may not always be adequately reflected in the private rate of return realized by rail operations. Even though this rationale for government support may be widely accepted, basic differences remain concerning the most appropriate recipients of assistance as well as the effect of rail subsidies on other modes of transport:

- It is frequently suggested that, as a general principle, the users of rail transport should pay the full cost of service wherever possible. The rationale underlying this position is that, if larger national or regional goals justify a subsidy, payments should be made directly to the individuals (or firms) that it is thought would be harmed by the higher rates. It is contended that pricing in this way would not distort choices between rail and other modes of transport or between transport and other types of expenditures.

- A second common point of contention concerns the equitable treatment of various modes of transport. Although several commodities (and many people) will certainly travel on their present modes even in the absence of government assistance, both the form and level of rail subsidies can induce shifts away from other modes (e.g., bus, trucking and marine).

This Submission does not attempt to resolve the long-standing questions of user-pay and inter-modal equity. However, both the economic significance and political sensitivity of these issues should be borne in mind when considering the particular financial techniques discussed in the following sections.

II. FINANCIAL SUPPORT OF RAIL IN CANADA

In recognition of the vital importance of rail transport for the continued development of this country, financial support has been extensive and has taken many forms. Table 2 indicates the amount of assistance provided by the federal government in recent years.

GOVERNMENT OF CANADA EXPENDITURES ON RAIL TRANSPORT ($000's) Table 2

	Operating Subsidies	Capital Subsidies	Grants & Contributions	Total
1978-1979	65,831	43	70,000	135,874
1977-1978	2,454	140	548	3,145
1976-1977	2,717	-	67,877	70,594

Note: Payments to VIA and other miscellaneous expenditures are not included.

Source: Public Accounts of Canada, Vol. II, Details of Expenditures and Revenues: 1978-1979.

The Railway Act (1888, as amended) provides the federal government with the statutory authority to support rail operations under specified terms and conditions. The following sections are particularly relevant here:

- Section 256: allows the Canadian Transport Commission to subsidize lines of railway deemed by it to be "uneconomic". Assistance is to be provided in the form of ex post compensation.

- Section 258: allows the federal government to provide grants to railroads in order to prevent the closure of certain branch lines.

- Section 261: allows the Canadian Transport Commission to subsidize any current passenger rail service deemed by it to be "uneconomic". The carrier is required to establish the extent of losses actually incurred when applying to the Commission for compensation. Compensation shall not exceed 80 per cent of losses incurred on the operation in question.

Further details of these and other provisions of the Railway Act can be found in Revised Statutes of Canada, Volume VI, Chapter Pl/5-8, RSC R-2.

All modes of transport in Canada receive some kind of financial support, whether direct or indirect. Although greater absolute amounts may go to road and air transport, the evidence appears to be mixed as to whether, on a per-unit basis, rail is the most heavily-subsidized mode.

III. FINANCIAL SUPPORT OF RAIL IN THE UNITED STATES

This section discusses three major recent initiatives for the financial support of rail transport in the United States. A brief account of proposed changes is also included.

The Railroad Revitalization and Regulatory Reform Act

In 1974, the U.S. Congress enacted the Regional Rail Reorganization Act in order to provide rail service continuation subsidies in designated areas. Two years later, this program was combined with regulatory reform initiatives to form the Railroad Revitalization and Regulatory Reform Act (1976). The major features of the Act are as follows:

- A program of declining-share federal operating and capital subsidies (100 per cent in the first year, declining to 70 per cent in the third year) to ensure continuing rail operation. The remaining portion of the subsidy payments may be shared by state and/or local governments.

- Funds for the rehabilitation of lines have been increased. The federal government is authorized to provide up to 80 per cent of costs, up to a specified ceiling.

- Increased funding for the acquisition of rail lines and other infrastructure.

Assistance may take the form of interim operating subsidies, rail service continuation subsidies, and grants for research and development. It has been reported that several of the states have begun to actively participate in cost-sharing of projects carried out under the authority of the Act.

Amtrak

The National Railroad Passenger Corporation (AMTRAK) currently operates approximately 27,000 miles of track. An Amtrak operating subsidy of $650 million has been proposed for 1981. This would represent a $20 million increase over fiscal year 1980. It should be noted that a rather intense political controversy has emerged regarding the continuation (to say nothing of the expansion) of Amtrak subsidies. News accounts report that 18 per cent of Amtrak route mileage was dropped in October 1979. It has been estimated that Amtrak fares cover 43 per cent of the costs of passenger rail service -- up from an estimated 41.5 per cent in 1979 and 38.5 per cent in 1978. Financial assistance has taken the form of operating subsidies, loans and capital grants.

Conrail

The Consolidated Rail Corporation (Conrail) was formed in 1976 by the amalgamation of the Penn Central and six other northeastern railroads after the bankruptcy crisis of that period. In 1979, some 3,543 miles of rail lines were covered by Conrail subsidies. Conrail has been allocated $3.3 billion since 1976. Reportedly, its losses for 1979 were $178 million, down 54 per cent from 1978. Conrail has apparently lobbied for major regulatory reform initiatives and the abandonment of unprofitable branch lines.

Possible Changes: The Current Public Discussion

Among the proposed changes currently under discussion are the following:

- a shift toward a common federal matching share for all projects (e.g., 70 or 75 per cent);
- a higher proportion of formula allocation as opposed to discretionary grants -- to form a better basis for predicting the amount of funding available to local areas;
- fewer federal standards and regulations which tend to increase the cost of construction or operation;
- a move toward block grants for rail transportation similar to community development block grants.

IV. OTHER FOREIGN EXPERIENCES

Eurofima

Eurofima is jointly owned by sixteen nationalized European railway companies. It is empowered to make loans at below market rates of interest, primarily for the purchase of rolling stock. New rolling stock is supplied to member railroads under equipment financing contracts, with Eurofima retaining title to the equipment until the final payment has been received. Loans are made by Eurofima to member railroads with guarantees provided jointly by the member companies.

West Germany

During 1974-76, the federal government announced a 28 billion DM rail assistance package ($19 billion in 1980 Canadian dollars). Assistance was reportedly in the form of investment grants and operating subsidies. Under the investment grant scheme, it appears that government rebates are provided for a specified portion of investment expenditures. Further details are not available in the public record.

Venezuela

A three-stage rail rejuvenation program is currently underway, with total expenditures eventually expected to reach the equivalent of $2.6 billion (Canadian). The program -- scheduled for completion in 1990 -- seeks to use rail transport as a tool for economic development by linking industrial sites, agricultural areas and ports. No further details pertaining to the allocation of funds or the particular financial instruments employed are available.

Hong Kong

In 1975, the government of Hong Kong established the Mass Transit Railway Corporation in order to construct and operate a mass transit rail system. Progress is reportedly proceeding on schedule. Table 3 provides some data on expenditure levels and types of financial support.

SOURCES OF FINANCE FOR THE MASS TRANSIT RAILWAY CORPORATION (HONG KONG), AS OF 1976[1] (in Millions of Hong Kong Dollars) — Table 3

Hong Kong Government Equity Capital	800
Syndicated Loan[2]	500
Export Credits[3]	3,400
Corporation Issued Bond[4]	400
Portion of Project Expenses Yet to be Negotiated	1,600
Total Estimated Cost	6,700

1. Latest data available.
2. Guaranteed by Hong Kong government as to principal and interest.
3. Provided by companies of foreign countries for purchase of goods and equipment.
4. Issued in 1976 for 10 years with no purchase attached to it.

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9. Financial World, Getting Railroads Back on Track; May 14, 1975.

10. Globe and Mail, Traffic Does Not Justify Passenger Rail Service; November 22, 1979.

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25. Wall Street Journal, Strong Medicine for Conrail; February 7, 1979.

CONSTRAINTS ON EFFICIENT AND

EFFECTIVE RAIL TRANSPORTATION

Prepared For:

ONTARIO TASK FORCE ON

PROVINCIAL RAIL POLICY

Strategic Policy Secretariat
Ministry of Transportation
and Communications
July 29, 1980.

Foreword

This report provides the Task Force with a list of well known constraints to the national rail system as advanced by many knowledgeable rail experts (note attached bibliography).

It was understood that this task would look at constraints from both the user (passenger, shipper) and supplier (rail company) perspectives. The literature, however, offered more commentary on the latter.

This deficiency on the user side was not seen to be a major shortcoming to the researchers. It is envisioned that the Task Force, in conducting its interviews, hearings and discussions with various interested parties, will be well fortified with a myriad of shipper and passenger complaints which will serve as a list of user "constraints". No doubt these complaints will be rooted in the following inherent disadvantages facing specific users in the Province:

- low shipper and passenger volumes
- great distances encountered mostly by shippers in Northeastern and Northwestern Ontario
- a costly Canadian Transportation Commission process in order to seek relief from high freight charges
- lack of competition from other modes (commonly known as "captivity") allowing railroads to charge allegedly high rates
- equipment shortages (usually box cars, bulkhead flatcars) which are being used in services elsewhere
- in effective marketing practices by railroads to attract passenger traffic.

In addition to listing the constraints, a brief section has been added to the end of the report on "productivity". These favourable statistics have been supplied to offset or balance the paper which could otherwise be construed to be negatively biased against rail. In addition, these statistics may provide a rationale or defense for certain railway actions which are seen to be simply "constraints" by others.

IMPEDIMENTS TO EFFICIENT AND EFFECTIVE RAIL TRANSPORTATION

(Contents)

1.

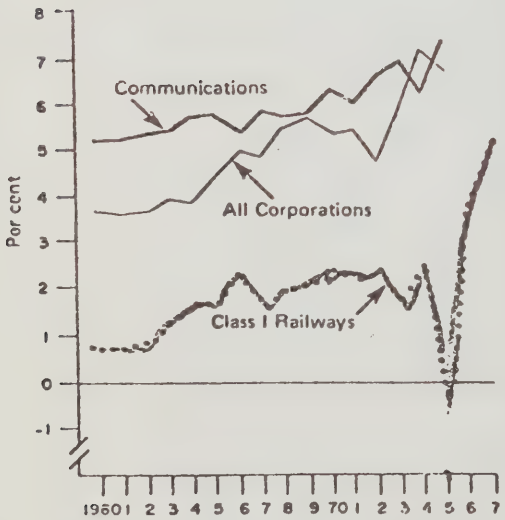
FINANCIAL CONSTRAINTS

a) Rates of Return

Reference: Canadian Transport Commission
Transport Review - Trends and Selected Issues
February, 1977
J.H. Spicer "Capital Requirements in the Railroads - The Next Twenty Years" in Transportation Research Forum, 1976
Edward Abbot in "Aid is Urged at Probe to Help Railway Safety" by John Quinlan, Toronto Star July 8, 1980
"Manitoba Hunts for Hay All Over Southern Ontario" Globe and Mail June 30, 1980

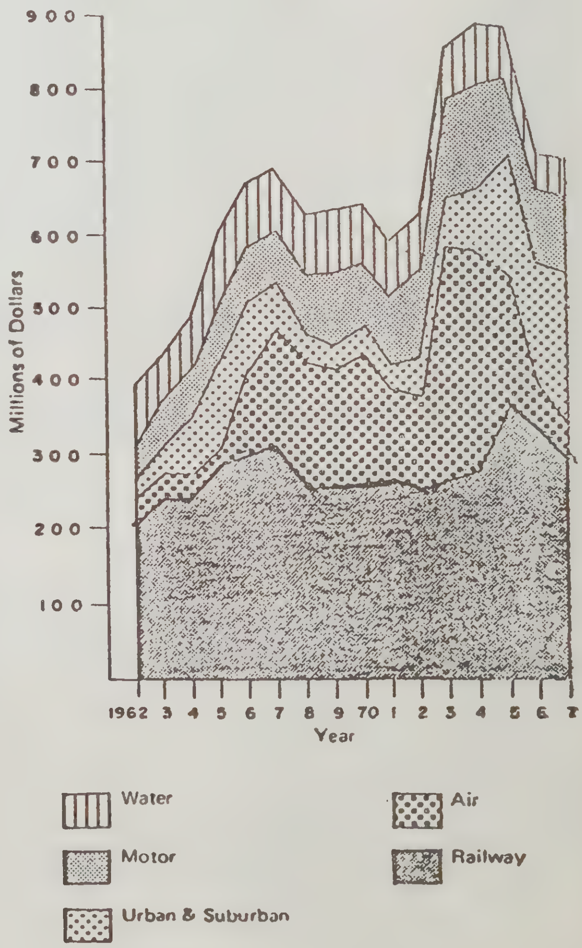
- The railways' rates of return are said to be inadequate. They are far too low to generate adequate investment funds internally or to attract from external sources sufficient investment capital to meet the needs for replacement and modernization of the railway system. (see charts below)

Annual Rates of Return — Class I Railways, Communications and All Corporations: 1960 — 1977



Reference: Canadian Transport Commission
Transport Review - Trends and Selected Issues March, 1979

Gross Investment of Transport Firms: 1962 — 1977
(millions of 1961 constant dollars)



- There has been a lack of coordination in rail's investment funds. As a result, there is expensive duplication of facilities in some areas and a serious deficiency of facilities in other areas.

- A clear example of the railways inability to respond to new opportunities occurred only last June 1980. At that time it was necessary to move surplus hay from Ontario to drought areas of Manitoba. Ontario farmers had great difficulty obtaining rail cars to move some 25,000 bales a week.

- In general terms we are entering a period where certain societal demands (i.e. safety) can be satisfied in terms of technological achievement but economically beyond the financial capabilities of railway companies. In such cases it may be necessary to entertain the possibility of further financial assistance to railroads.

b) Capital Crunch:

Reference: J.H. Spicer "Capital Requirements in the Railroads - The Next Twenty Years" in Transportation Research Forum 1976
Canadian Transport Commission Transport Review - Trends and Selected Issues February, 1977

- It is predicted that there will be strong growth in capital demand by the Canadian economy over the next few years. Yet, there is an anticipated scarcity of capital. Capital is fast becoming an endangered species.

- In relation to this, certain indications show that the most significant increase in needed investment is expected to occur in the rail mode. There will be an increasing need for investment in rail facilities and equipment.

- Why? As energy becomes increasingly scarce people will look more to rail as a primary mode of transportation.

- According to a CTC study on the ability of the transport industry to attract investment capital, rail is not in a favourable position to compete for funds on the capital market.

3.

- How much capital will be required?

  i) To retain a viable rail industry; to provide for commercial growth and potential, to make improvements to increase productivity, to provide also for national expansion projects.

  ii) A CN employee predicts that CN will be needing approximately 250 million dollars a year of investment capital.

- In the future railways will not be able to meet sudden and unexpected demands as quickly and as efficiently as in the past because of the shortage of capital.

c) Crows Nest Pass Agreement:

Reference: A.W. Currie Canadian Transportation Economics University of Toronto Press, 1967
J. Lukasiewicz The Railway Game McClelland and Stewart Ltd., 1976
Canadian Transport Commission Transport Review - Trends and Selected Issues February, 1977
C.D. Nachtigall, F.G. Skinner and E.W. Tyrchniewicz "Crows Nest Pass Grain Rates: Time for a Change?" in Transportation Research Forum, 1975
R.N. Wolff and C. Kuazer "The Future of Truck and Rail Modes as Carriers of Freight in Canada" Report #63 University of Toronto/York University Joint Program August, 1979
Canadian Transport Commission Transport Review - Trends and Selected Issues March, 1979

- The Crows Nest Pass Agreement was signed by the Dominion Government and the Canadian Pacific railroad in 1897. The agreement involved the construction of a railway from Lethbridge, through Crows Nest Pass, to Nelson British Columbia. The construction was sponsored by a government grant of $3,400,000. In exchange for this grant CP would reduce its grain and flour rates by three cents per hundred pounds without limit of time.

- The reduced rates became effective as of 1899 and only were applicable to the CP lines. In 1925 legislation made the reduced grain and flour rates applicable to all railways.

- Since 1899 wage rates have risen, materials cost more, traffic volume has grown and interest rates have risen yet the rates on export grain from the west remain the same as those of 1899.

- This agreement has created the following problems and inequities:

  i) Distortions re: the allocation of resources and maintenance.

  ii) The indirect subsidization of grain traffic by the government through purchasing hopper cars, repairing box cars and subsidizing branch lines. As a result of this there is overinvestment in branch lines making rail transport artificially cheap and branch lines uneconomic.

  iii) Rail users may face higher tariffs on certain commodities as railways attempt to recover the losses on the grain shipments.

  iv) Grain traffic has been made unprofitable in western regions; therefore has been disinvestment and hence a deterioration in the rail facilities for grain transport.

  v) The Crows Nest rates have indirectly contributed to the labour problems in rail because they have caused decreased revenues for rail companies therefore railways are not able to pay wages to their employees as high as they otherwise would (Chief Justice Sloan of BC - an arbitrator in a labour dispute).

vi) Contribution to revenue loss:

a) according to the Snavely Commission, in 1974 the total cost of transporting grain by rail was $234.4 million. Total revenue for rail in 1974 was $145.1 million. Therefore, the revenue loss, as a result of the statutory grain rates, amounted to $89.3 million.

b) according to a CTC report, in 1976 grain and grain products travelling at the statutory rates provided only 4.9 percent of revenues, against a 19.7 percent share of tonne-kilometres.

d) Subsidies

Reference: Canadian Transport Commission Transport Review - Trends and Selected Issues March, 1979
J. Lukasiewicz The Railway Game McClelland and Stewart Ltd., 1976

- In 1977 the railways received over two-thirds of the direct subsidy payments granted by the Federal Government to transportation. Uneconomic passenger services accounted for approximately 60 percent while uneconomic branch lines accounted for 26 percent of the railway payments. Alberta, Manitoba and Saskatchewan are the only provinces to receive subsidies for branch lines.

- Although railways do receive a generous amount of government subsidies for specific areas, some important areas of the mode are not alloted public funds. In the area of research and development railways have recently not been receiving any subsidies. This hinders the needed modernization process of rail (a discussion on which will follow). For the high costs of rail infrastructure, railways also do not receive subsidies.

- All provinces, except for the Yukon and Northwest Territories, receive subsidies in the form of the Grade Crossing Fund.

Maritime Freight Rates Act

Reference: D.V. Bell "Freight Rates and Transportation Policy" Report #45 University of Toronto/York University Joint Program March, 1978

- This Act was passed in 1927, providing a 20 percent government subsidy to specified freight traffic in the Maritimes.

- The subsidies are only applicable to certain freight traffic moving within the Maritimes region.

- The 1969 Atlantic Region Assistance Act extended the subsidy rate to 30 percent and was made applicable to Atlantic trucking along with railways. Accordingly, this Act has created a situation where Ontario directly and indirectly subsidizes artificially low freight rates for the East.

AT and EAST Rates Subsidy

Reference: H.L. Purdy Transport Competition and Public Policy in Canada University of British Columbia Press, 1972

- Applied as of 1961 to bulk export grain moving from points on the Great Lakes, Georgian Bay and the St. Lawrence River to export ports in Canada.

- Rates are frozen at the 1960 level and subsidies are granted to railways when the frozen rates are below the compensatory level or exceed the variable cost of service.

- The subsidies are only applicable to Maritimes railways, therefore Ontario railways are excluded.

- The AT and EAST rates subsidy prevents significant diversion of freight traffic to United States ports.

7.

ENVIRONMENTAL CONSTRAINTS

a) Weather:

Reference: J. Lukasiewicz The Railway Game University of Toronto Press, 1976
H. Colijn "Freezing Problems During Rail Transportation" CIGGT Report, July, 1972

- Canada's unique weather can act as an impediment on rail efficiency:

  i) Snow has been a major problem in relation to "on-time" performance, track problems, etc.
  Example: In 1972 for every ten inches of snow the Rapido trains on the Montreal-Toronto route decreased their "on-time" performance by 20%

  ii) some railways in winter never reach their destinations at all.
  Example: Between February 22nd and March 7th of 1972, two transcontinental trains never reached their destination while others faced a delay of approximately fifty hours.

  iii) Winter shipments may encounter freezing problems. Moist raw materials tend to freeze during shipment. This can cause operational and economic problems. Railways may face delays and major expenses for demurrage charges. Also, as trains run faster there is heat loss which adds to the freezing condition. Many trains are forced to travel slower which effects their time performance.

b) Transport of Dangerous Goods

- New legislation and regulations covering the transportation of dangerous goods which now has a new sense of urgency as a consequence of the Mississauga incident, will likely be passed in the next Federal Parliament. This legislation will act as an impediment in two areas:

i) Cost of replacement equipment:
The likely cause of the derailment in Mississauga was an overheated journal bearing. The railways move to equipment with roller bearing equipped journals is a slow process. New equipment (since the 1960's) is equipped with the new type of bearing, yet many thousands of cars with the old type of friction bearing remain in service. The railways may be forced to accellerate the program of change by scrapping existing rolling stock and replacing it with roller - bearing equipped cars.

ii) Operational impediments
Recommendations emanating from the Grange Commission could impose operating impediments on the railways. Recommendations could include more stringent speed limits, shorter trains, re-routing around populated areas, etc.

c) General Environmental Pollution

Reference: Office for Research and Experiments of the International Union of Railways "Environmental Pollution by the Railways" UTRECHT April, 1976

- In comparison to other transport modes rail holds a privileged position as far as environmental pollution is concerned.

- General impact of environmental pollution on railways:

i) It obliges the railways to bear considerable expenses, in order to reduce the pollution caused by them.

ii) It leads to delays in the realization of some badly needed projects of modernization; as investigations by public authorities prior to authorization of new developments, involving problems of noise and other kinds of pollution, may take considerable amounts of time.

- Yet, it gives the railways an advantage over their competitors, in that they are by far the least polluting transport system.

Noise

Reference: MTC "Railway Noise - State of the Art" November 1975

- railways cause "ground-born" vibrations which disturbs those residing adjacent to the rail line. Noise has been increased by poor track and vehicle maintenance.

d) Energy

Reference: R.N. Wolff and C. Kuazer " The Future of Truck and Rail Modes as Carriers of Freight in Canada" Report #63 University of Toronto/York University Joint Program August, 1979

- With diesel fuel becoming an increasingly scarce resource, rail is facing the problem of finding some other source of locomotive power.

- Rail electrification appears to be a major consideration in Ontario given the abundance of hydro - electric power. A major deterrent to electrification, however, is the large capital costs involved. It is estimated that it would cost $320,000 per mile to electrify rail, therefore, electrification of Canadian railways could total $3.3 billion.

- Research has also began on the use of hydrogen as an alternative to fossil fuel.

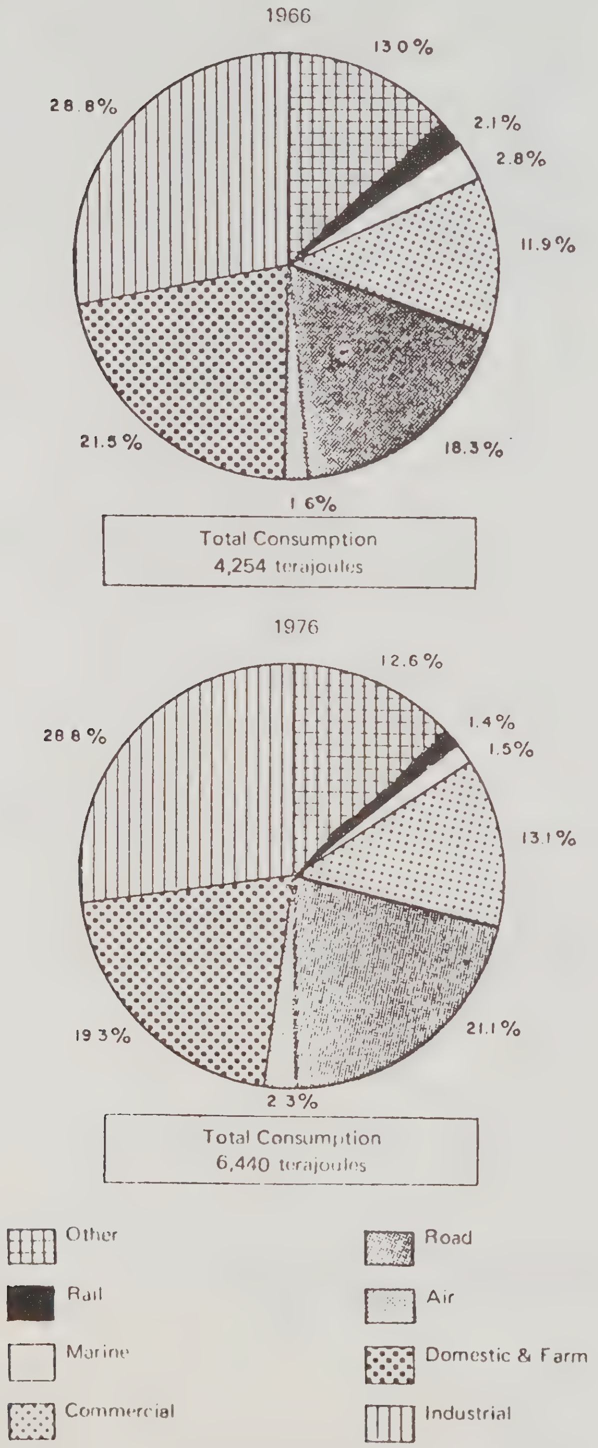
- Energy consumption by sector:

- In the 1960's air was the mode which consumed the least amount of fuel energy. In the 1970's the rail mode consumed the least amount of energy as compared to marine, commercial, road, air, domestic and farm, and industrial. (look at attached chart)

9a.

Reference:
Canadian Transport Commission <u>Transport Review - Trends and Selected Issues</u> March, 1979

Energy Consumption by Sector:
1966 & 1976



Source: Statistics Canada Catalogue Nos. 57-207 and 57-505 and the Manufacturing and Primary Industries Division, Statistics Canada

SOCIAL CONSTRAINTS

Reference: Canadian Transport Commmission "Transcontinental Passenger Train Hearings" September, 1976
F. Frisken and M. Keall "Travel Behavior and Transportation Attitudes Among Young Adults" Report #47 University of Toronto/York University Joint Program May, 1978
Canadian Transport Commission Transport Review - Trends and Selected Issues March, 1979
J. Lukasiewicz The Railway Game McClelland and Stewart Ltd., 1976

Behavioural and Attitudinal Impediments:

i) Automobile Attachment:

- In Canada there is evidence of the general population having a strong attachment to the automobile. People are "car-oriented".

- At the earliest possible age a large number of people turn to cars as a primary source of transport.

- An overriding detriment to the use of urban rail transit appears to be automobile ownership.

- Even if the rail service provided is considered satisfactory or good, this may not cause a person to switch from using a car to using railways.

ii) Cost:

- Considered to be a detriment to the use of rail by the public.

- Travellers argue that the numerous fare increases since 1970 have been far too steep.

iii) Time:

- In a CTC survey of Maritime rail passengers the findings showed that most considered the major weakness of rail to be inconvenient timing and longer travel times.

- Canadians are very conscious of time - time is considered to be a valuable commodity not to be wasted. In relation to this, Canadian railways have been found to be lacking good "on-time" performance. Example: In 1972 the CN trains from Toronto to Montreal - 72% arrived on time - 50% arrived on time in the four main winter months (a time of year when many turn to rail, rather than driving).

TECHNOLOGICAL CONSTRAINTS

Reference: J. Lukasiewicz The Railway Game McClelland and Stewart Ltd., 1976
T.D. Ganton, J.A. MacDonald, R.W. Lake et al. "A Survey of Rail Passenger Transportation" CIGGT March, 1975.
G.P. Raymond "Some Track Support Problems" in "The Eighties: A New Rail Era" edited by R.W. Lake, C.S. Schwier and S.N. Arnold CIGGT April, 1978

There is evidence of a "technological gap" in Canadian rail.

- Have had some technological advancement in containerization, computerization, and automation of location identification and yard operations.

- Yet, there is a "gap" in such areas as: traction, suspension, structural efficiency or weighing of rolling stock, track construction, signalling and traffic control.

- General passenger equipment is outdated - almost 50% of CN's passenger equipment is 21-25 years old, 83% of the railway's equipment is over 20 years old. 40% of CP's passenger equipment is over 20 years old.

- One major reason for these technological impediments is the lack of capital available to sponsor technological advancement in rail - resulting in "technological neglect".

Traction:

- Since the conversion from steam to diesel in Canadian railways (completed in early 1960's) the modernization of traction has come to a halt.

- Electric traction has not been introduced, yet it is an important benefit to rail efficiency.

- Electric traction is superior to diesel because it is less expensive, develops more horse power, gives a longer pull, better suited for higher speeds, has cheaper maintenance costs and longer life.

Rolling Stock

- Canadian rolling stock is much heavier than it need be. Heaviness effects time and general train performance. In comparison, a light weight structure has better braking and acceleration performance, smaller wear, less damage to track, smaller maintenance costs and higher safety.

Track:

- There is evidence of "deferred maintenance".

- Lack of adequate maintenance of tracks can be hazardous for rail traffic.

- Proof of this is in the increasing number of derailments. Since 1970 derailments have increased from approximately 260 in 1970 to over 400 by the mid 1970's.

- Poor track conditions prevent the use of modern high speed trains as used elsewhere, which can travel up to speeds of 200 miles per hour.

Traffic Control:

- There has been the development of a highly efficient and effective system of traffic control entitled "Centralized Traffic Control".

- This system has been slow in being applied to rail in Canada.

- As of 1976 only 14% of the rail return was controlled under this system.

Physical Make-Up:

- Rail is only one-dimensional; it can only move in one direction (unidirectional). This is an indirect impediment in relation to rail competing with other modes of transportation.

- Since rail is unidirectional, its movement is highly interdependent.

- No technological advancement has provided the needed centralized control in view of this interdependence. There is a need for an integrated organization of all tracks for rail to run efficiently.

INSTITUTIONAL CONSTRAINTS

a) Canadian Transport Commission:

Reference: Report of the Auditor - General to the House of Commons March 31, 1979
RTAC "Issues in Jurisdictional Responsibility and Accountability - Today and Tomorrow" October, 1975
J. Lukasiewicz The Railway Game McClelland and Stewart, 1976
J. Lukasiewicz "The Dilemma of Passenger Rail in Canada" in "The Eighties: A New Rail Era" edited by R.W. Lake, C. Schwier and S.N. Arnold CIGGT April , 1978

- In a report from the Auditor General, March 31, 1979 several impediments are noted:

  i) the CTC does not possess the adequate procedures to ensure that there is proper verification of the loss claimed by a railway company and certified for payment out of the Consolidated Revenue Fund

  ii) the CTC lacks the objective information to evaluate the effectiveness and impact of their rail programs

  iii) applications to abandon uneconomic branch lines and discontinue uneconomic passenger services require public hearings and extensive analysis before any decision is made by the CTC. The process at present requires 3 to 4 years before a decision is rendered

  iv) while waiting for this application to be approved, the companies are protected with operating loss guaranteed subsidies for only 1 1/2 years. As most decisions take 3 to 4 years, a company may be unprotected for 1 1/2 to 2 years

- Following the 1967 National Transportation Act, the roles of the CTC and Transport Canada have become blurred and confusing:

  - the CTC was intended to primarily be only a regulatory body (e.g. rail safety). It now has input into policy and program management and administration. (e.g. rail passenger services, Atlantic Freight-Rate Subsidies)

  - Transport Canada was intended to be an administrative body only. It now acts also as a regulatory body.

- Certain CTC decisions have impeded passenger rail in Canada. The decisions ordering railways to continue running uneconomic services hinders the economic viability of railways. Example: transcontinental services continue to run even though they account for 60% of the revenue losses in the rail sector.

- For those using rail the CTC does not ask railways to supply information on standards of service such as punctuality of trains and actual trip time. Also there are no standards for service quality.

b) VIA Rail:

Reference: J. Lukasiewicz "The Dilemma of Passenger Rail in Canada" in "The Eighties: A New Rail Era" edited by R.W. Lake, C. Schwier and S.N. Arnold CIGGT April, 1978

- VIA Rail was created in 1977 to integrate passenger operations and revitalize the rail industry.

- With the technological impediments and lack of capital to improve roadbed and signalling, VIA's schedules will not be significantly shortened, nor will the railway's competitive position be bettered.

c) Labour:

Reference: A.W. Currie Canadian Transportation Economics University of Toronto Press, 1967
J. Lukasiewicz The Railway Game McClelland and Stewart Ltd., 1976
R.N. Wolff and C. Kuazer "The Future of Truck and Rail Modes as Carriers of Freight in Canada" University of Toronto/York University Joint Program August, 1979

- There are approximately twenty labour unions to which Canadian railway workers belong. The unions have endorsed certain working and payment rules which are detrimental to rail efficiency.

Wages:

i) Since 1974 labour unions have frequently used the "Hall Formula" to justify their demand for higher wages. The Hall Formula ties wage increases to the cost of living, productivity and catch-up. If this formula had been applied in 1979 wage increases for rail employees would have been 14 to 16% in the first year.

ii) To cover the increasing expenses of labour wages railways are forced to increase freight rates. It is very hard to increase rates without losing traffic to competitors.

iii) The method of wage payment used by Canadian railways has some restrictive elements. Example: locomotive engineers in passenger service must stop work when they reach 4,500 to 4,600 miles per month of travelling time - some may complete their route quickly so junior engineers take over, leaving a long lag before the qualified men return to duty.

Working Rules

- Railway unions are often criticized for their restrictive working rules which "throttle" the rail industry and prevent it from competing effectively with other transportation modes.

- According to the unions the rules have been designed to "protect the worker against actual or potential abuse of his legitimate rights".

i) Working rules are primarily based on early steam locomotive technology:

   - some trains stop for unnecessary servicing every 125 miles

   - direct locomotives are manned on the basis of steam traction requirements - e.g. having firemen

   - any attempts to counteract these frequent stops and have "runthroughs" are opposed by the unions

   - example: on the CN Montreal-Toronto line the Rapido trains are to be non-stop yet they halt twice (in Brockville and Belleville) to change the engine crew

ii) There is a problem of overmanning where railways must keep in employment redundant crewmen; such as a rear-end brakeman and a conductor on freight trains.

iii) One rule stipulates that shopmen must be paid for a minimum of five hours for any work done outside of regular hours.

iv) Unions want special protection against loss of property values when divisional points and unprofitable branch lines are abandoned. They are entitled to compensation for the loss in the selling prices of their homes.

Collective Bargaining:

- The proliferation of railway unions has complicated the collective bargaining process in rail.

- The two men sitting on the conciliation board rarely remain impartial. They usually can not agree upon a chairman, therefore, forcing the Minister of Labour to appoint a judge.

- Most opinions of the conciliation board are not accepted by labour leaving the only alternative to be government intervention in order to avoid a strike.

d) Access to United States and Other Parts of Canada

- Ontario's key markets are located in the United States. Although politics dictate an emphasis on east/west traffic patterns (i.e. Canadian unity), the reality is that the major trading pattern for Ontario is north/south.

- Certain rules, regulations and technical standards are different between the U.S. and Canada and can serve to create impediments to a free flow of goods.

- For example: "Clearances" or allowable weight (maximum rated capacity) on the roadbed may be different on certain U.S. lines than in Canada. Depending on the particular market location, certain rail cars may be prohibited over certain routes due to weight restrictions.

- The growth in tonnage through Thunder Bay (example wheat, potash, coal, lumber, and wood pulp) could place severe pressures to upgrade and expand the rail system further at this location. Ontario must preserve this vital access to the growing markets of Western Canada.

20.

RAILWAY PRODUCTIVITY

Reference: Canadian Transport Commission Transportation Review - Trends and Selected Issues
March, 1979

1967-1975

- short term range of productivity for Canadian railways

Inputs:	Labour:	6.05%	average annual increase
	Way and Structures:	1.8%	average annual increase
	Equipment:	-0.8%	average annual increase
	Fuels:	-0.4%	average annual increase
	Materials:	0.4%	average annual increase
Output:	Total Productivity:	2.9%	average annual increase

1956-1975

- long term range of productivity for CN and CP rail

Inputs:	Labour:	-3.1%	average annual changes
	Way and Structures:	1.2%	average annual changes
	Equipment:	2.0%	average annual changes
	Fuels:	-5.2%	average annual changes
	Materials:	1.7%	average annual changes

Weighted aggregate Inputs: -1.2%

Output:	CN	CP	CN & CP combined
Ton miles:	3.0%	2.7%	2.9%
Passenger miles:	-0.2%	-7.8%	-2.9%
Weighted aggregate output:	2.3%	0.8%	1.6% (annually)

General expenses in relation to productivity: 1956 to 1975

labour - 50% of total railway costs
way & structures
equipment, material } >15% of total railway costs
Fuel: - 5% of total railway costs

- Over the period of 1956 to 1975 the two major Canadian railways were increasing output, while reducing utilization of inputs.

- While the utilization of equipment increased, labour and fuel inputs were reduced.

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GO TRANSIT COMMUTER RAIL OPERATIONS

The Problem

Government of Ontario Transit (GO) rail service to downtown Toronto from surrounding municipalities has successfully demonstrated the potential of using railway rights-of-way for the daily movement of people to and from their place of work.

Public acceptance has resulted in passenger carryings at levels which render commuter rail more efficient in terms of energy consumption than the private car or bus transit. Experience has shown that where fares are held at competitive levels with perceived car costs, revenue-to-cost performance on GO train operations are generally in line with transit operations elsewhere in the country.

In 1978, conditions were drastically changed: a new contract was executed with Canadian National covering operation of GO train service on CN's rights-of-way. New conditions imposed by CN virtually doubled the price which would have been applicable under the original operating agreement. While part of the new cost can be justified as compensation for the railway's indirect costs, much of the increase provides additional profit to CN. The action threatens the viability of existing GO train services and clouds the prospects for much needed expansion and extension of services.

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It has become a question of CN profitability versus GO viability; a matter of public policy governing the relationship of one crown agency to another crown agency.

CN's Historic Obligations

In 1923 the Canadian National was established with taxpayer dollars, to provide Canadians with a transportation service deemed essential to the nation's cohesive development. Without state ownership, subsidies and/or revenue guarantees, private enterprise was manifestly not prepared to venture the investment.

Profitability, then, was not a prime objective of the federal government in setting up CN as a Crown Corporation; meeting the public need for transport was the acknowledged prerequisite. In fact, for many years Ottawa subsidized passenger services to the extent of 80 percent of any operating deficits incurred; calculation of such deficit did not include the "profit" element as such.

The Understanding During GO's Implementation

GO commuter rail operations are substantially subsidized from the public purse, a situation accepted from the outset by the Province of Ontario. In the deliberations leading to the first GO service both national railways were consulted. Understanding was reached that the proposed commuter service would be operated on otherwise

.../3

idle capacity. Statements were made in 1962 by the presidents of both railways that capacity for commuter operation would become available on some rail lines following the opening of the freight marshalling yards to the north of Metropolitan Toronto. It was accepted that the Province would compensate a railway for the use of such idle capacity by paying an equitable share of all costs associated with ownership and maintenance, including interest and depreciation. In 1963, J.A. McDonald, CN vice-president, stated in an article in Canadian Transportation, "...Canadian National is willing to provide any form of commuter service on a contractual basis that will recoup expenses". Initially, no mention was made of a mark-up for profit.

Following extensive feasibility study, negotiations were opened with CN for the conduct of a service on the Lakeshore trackage between Oakville and Oshawa. Proposed terms, approved in principle by CN, held the Ontario Government responsible for all changes and additions to the CN plant required for the commuter service.

CN would be compensated for all new direct expenses created by the commuter operation; for a proportionate share of all actual expenditures for the operation of the Oakville and Oshawa sub-divisions, and of the Toronto Terminals Railway facilities;

.../4

for a proportion of CN's fixed expenses such as interest and depreciation charged against the railway's investment in plant and facilities on the two subdivisions. There would also be a fee for management, administration, and supervision. Thus, CN would experience no out-of-pocket cost, and receive a valuable contribution towards overhead. Of even greater benefit the railway was to be relieved of responsibility for providing the very costly, twice daily, CN passenger train service between Hamilton and Toronto.

In the spirit of the original concept, these terms would provide the people of Ontario with a commuter service without the large capital cost of establishing new rights-of-way and would improve the financial position of CN. It would be mutually beneficial to both parties. The questions of return on investment or right-of-way rental did not arise.

The First 10 Year Agreement

A master operating agreement covering the first ten years, 1967 to 1977, was signed between CN and GO Transit in 1969. The cost of plant modifications which in the 1965 agreement were anticipated to be minimal, amounted to some $12 Million which were shared, $8 Million by the Province, $4 Million by the railway. Also, the original out-of-pocket cost recovery was changed to recognize the many on-going costs, including CN's ownership of right-of-way land and truck structure for which GO agreed to pay approximately $225,000 annually.

.../5

GO assumed liability for accidents involving GO-owned rolling stock regardless of possible negligence on the part of CN staff who were responsible for operating the service.

GO was obligated to pay for construction of new plant capacity should the initial idle capacity subsequently be required for CN's own operations.

All GO-funded plant additions became the property of CN.

While the terms of the signed agreement varied from those originally contemplated, the Province was satisfied; the commuter train was operational and well received without incurring the high cost of acquiring property and constructing an exclusive right-of-way. CN was in a much more favourable financial position than was the situation before 1967; it had been relieved of the heavy annual loss on the Hamilton passenger service; plant maintenance and operating costs which previously had been a charge against CN services were now being shared by the commuter service.

Difficulties Emerge

In 1974 additional GO service came into being between Toronto and Georgetown; in 1978 the Richmond Hill-Toronto line was opened. Each of these utilized CN rights-of-way. While the terms of the 1967-1977 Lakeshore Agreement were to set the pattern for compensation to the railway for these operations, interim Memoranda of Agreement

.../6

were introduced, pending negotiation of final terms which, of course, would be retroactive. The Georgetown agreement was expected to be incorporated into an operating agreement for all CN-operated services for a new ten year contract covering the period 1977 to 1987.

The new Master Agreement would automatically encompass the Richmond Hill service.

Agreement was required in two areas: in respect of on-going operations and in respect of capital improvements required. The Georgetown negotiations extended over a period of several years with no solution reached by 1977 when the original master agreement would expire. During this time the position of CN hardened. They moved from a cost recovery basis to a "bottom line" compensation for operations which would yield full commercial profitability. The matter of cost sharing of capital improvements on the Richmond Hill line was understandably a contentious item. The track and signal plant had been expanded and improved beyond the requirements induced alone by the new commuter train operation; CN's mainline freight operations would also benefit. How much of the new cost should be absorbed by each party? The railway would not agree to calling for an outside assessment by impartial specialists.

.../7

The Second 10 Year Agreement

Throughout these negotiations and those leading to the signing of a second ten year Master Agreement, Canadian National bargained from a virtual monopoly position: the Province had made massive investment in rolling stock and railway plant improvements, and, particularly for the Lakeshore corridor, had no practical alternative to the commuter rail service.

In a letter to the Honourable James Snow, Ontario Minister of Transportation and Communications, dated April 6, 1977, CN vice-president, Great Lakes Region, Mr. A.R. Williams, had this to say:

> "... in the absence of a satisfactory signed agreement by 22 May covering GO Rail service by Canadian National, we will be obliged to discontinue GO Rail operations as of that date".

There had obviously been a radical change in the stance of Canadian National vis a vis the Government of Ontario Transit operation. This can be traced in part to a restructuring of CN's corporate organization and, in part, to a change in the railways mandate through the new National Transportation Legislation of 1967.

The National Transportation Act came into force and was followed in 1969 with regulations governing accounting conventions to be followed by railways in costing and pricing their operations.

.../8

These constitute government directions to the railway companies. The policy statement of the Act reads, in part:

> 3. (b) each mode of transport, so far as practicable, bears a fair proportion of the real costs of the resources, facilities and services provided that mode of transport at public expense;
>
> (c) each mode of transport, so far as practicable, receives compensation for the resources, facilities and services that it is required to provide as an imposed public duty.

CN apparently interprets the Act to mean that the company is entitled to compensation, to cover all real costs, including a return on the money value of land and facilities and a margin for profit.

CN management outlook also changed in the early 1970's. Their organization was restructured for improved efficiency and corporate policy centred on profitability. The results, as illustrated by CN's financial statements, have been exceptional;

.../9

unfortunately the accomplishment, to a substantial degree, has been at the expense of the Ontario taxpayer in GO Transit subsidies. In a recent speech to the Toronto Society of Financial Analysts, Robert Bandeen, President of Canadian National stated:

> "A good example of this approach is the GO Trains, which CN provides on contract for the Ontario Government. The contract sets a rate which allows us to make a profit and the more efficient we are, the greater the profit. This way, even subsidized services are under the discipline of the bottom line".

Since under this policy profit is guaranteed as a mark-up on the cost of GO operations, there is no incentive for CN to reduce costs. Thus it is not efficiency but the reverse which could contribute to CN profits.

In summary, the conditions imposed on CN representatives by corporate policy during the negotiations on the ten year contract were as follows:

1. The "Bottom Line" policy adopted in 1976, established the expected profit from all divisions of CN, including CN Rail -- from all operations, including GO Transit.

.../10

2. GO was confronted with an ultimatum that failure to reach agreement on terms acceptable to CN and consistent with the "Bottom Line" policy would result in termination of services.

3. CN would not agree to a form of arbitration to determine the extent of plant modifications required to accommodate commuter rail.

GO Transit, on the other hand, contended that commuter rail, which had previously been subsidized by the federal government should not now be considered as a profit centre by CN; that Canadian National rights-of-way should be considered a national resource to be utilized in the best public interest.

It was contended too, that GO was not "just another customer":

- CN pricing to GO was not established in a competitive market;

- CN assumed no commercial risks in its dealings with GO;

- GO services were provided only after the commercial customers had been provided for;

.../11

- Unlike other customers, GO financed any new capacity required;

- Such new capacity became the property of CN as a gift from the people of Ontario.

With basic positions which were so incompatible, teams from CN and GO, with the best of goodwill and reasonable discussion met through 85 meetings over a period of 19 months in 1977 and 1978 and were unable to reach acceptable compromise. Faced with the ultimatum of termination of service by CN, the Province was forced to accept the railway's terms. The new 1977-1987 Master Agreement was signed in 1978.

Observations and Conclusions

As noted at the outset, the new terms add drastic new cost to the province -- on the Lakeshore corridor alone, the $225,000 annual user charge escalated to over $2.5 Million.

Since the original agreement gave CN full recovery of out-of-pocket costs, the new revenue would to a large extent be profit to the railway. The Province of Ontario was now offsetting all costs and paying what can only be called windfall profits. The concept of paying all real operating costs, a return on the value of land and facilities, and a margin for profit, imposed on top

.../12

of the original requirement to pay for all new capacity, would find the province paying more for the use of existing rights-of-way than for acquiring exclusive rights-of-way.

It is vital that existing rights-of-way be utilized where practicable and where demand warrants, rather than create new intrustions on the environment with massive new highway construction or expropriation of land for new rights-of-way. A way must be found to utilize economically the idle capacity existing on the national railway systems. Policy must first be developed at federal and provincial ministerial level, and in consultation with the directors of the national railways, which encourages such utilization and directs the negotiation of operating contracts which are equitable to both the concerned transit authority and the railway.

Basic criteria for development of the policy should recognize that commuter rail may be operated by the railway on a cost-plus, no-risk contract basis; or it may be dealt with as a commercial customer.

In the case of the commercial customer, the railway would assume the cost of new plant capacity and associated risks. Rates charged would be in accordance with currently approved regulations and costing methods, and would include full recovery of costs and a return on investment in plant plus profit margin.

.../13

On the basis of a no-risk contract:

- The railway would be held in a no-loss position.

- Commuter operations not be allowed to impair the railway's capability to serve its normal customer categories.

- New capacity required to accommodate commuter operations would be a charge against the transit authority; with provision for arbitration in case of disputes as to the extent of capacity required.

- All risks would be assumed by the transit authority.

TATOA

GEM - July 22, 1980

ENERGY AND TECHNOLOGY

IMPACT OF AVAILABILITY OF ENERGY RESOURCES ON TRANSPORTATION IN ONTARIO

Prepared For

ONTARIO TASK FORCE ON
PROVINCIAL RAIL POLICY

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IMPACT OF AVAILABILITY OF ENERGY RESOURCES ON TRANSPORTATION IN ONTARIO

Contents

Appendices

IMPACT OF AVAILABILITY OF ENERGY RESOURCES ON TRANSPORTATION IN ONTARIO

1 INTRODUCTION

Energy is one of the major issues facing Ontario as we enter the 1980's. All parts of the economy are facing rising energy prices and some sectors are experiencing short term problems with supply. The energy "problem" is one that is particularly relevant to transportation since it is over 99% dependent on petroleum energy. The transportation sector is also the largest user of petroleum energy in Ontario. As a result, both sudden and long term changes in the petroleum supply will have an impact on the transportation system. Therefore to conserve Canada's dwindling petroleum resources and to decrease our dependance on imported supplies, various ways of conserving petroleum energy are being explored and implemented.

The Ontario Task Force on Provincial Rail Policy has expressed a concern about the future availability of energy supplies and the effect that the availability may have on transportation in general and rail transport in particular.

This working paper is a response to these concerns and is intended as an assistance to the Task Force in addressing the energy related transport issues. It should be noted that the documentation of possible impacts which could result from an uncertain future is a highly speculative activity. The work in this paper should therefore be treated as such. However with that caution in mind, the paper will outline some relative changes in the transportation system that could result from constraints in energy availability.

The paper has four basic sections. The first presents three energy scenarios provided by the Ministry of Energy. The second section reviews available literature on the existing transport demand and changes in transport as it relates to energy usage. The next section provides an assessment of how the intercity passenger transport sector would adapt to a constrained energy supply. The last section summarizes the above material with particular emphasis on a strategy for meeting a constrained transportation energy situation in year 2000 as postulated in the scenarios.

Due to the time limitations under which this paper was prepared most information was taken from various data sources external to the Urban and Regional Transportation Planning Office. Although an effort was made to ensure the appropriate use of the information there may be difficulties, particularly related to the consistency between differing data sources. The Ministry of Transportation and Communications as part of its ongoing Transportation Energy Management Program will be developing an appropriate data base for future studies to overcome some of these problems.

2 ENERGY AVAILABILITY

The Ministry of Energy, in response to a request by the Task Force for a description of the future availability of energy resources by type, prepared 3 possible scenarios of petroleum availability for year 2000. The scenarios, shown on Table 1, are estimates generally based on recent changes in projections of population and income.

Scenario 1 postulates that by 2000, the petroleum availability will equal the 1980 availability for transportation.

Scenario 2, assumes a 10% decrease in petroleum availability by year 2000 for transportation.

Scenario 3 projects that the petroleum availability for transportation will match the growth in Ontario's population which has been forecast to be 0.8% per annum or 17% by year 2000 over the 1980 levels.

No estimate of energy availability for other fuel types was prepared. Discussions with Ministry of Energy staff indicated that alternatives such as electricity, methanol or hydrogen may be available, but would constitute an insignificant share in the transport sector by year 2000.

The Ministry of Energy has stressed that these scenarios are merely illustrative targets which provide a range for consumption related goals. The documentation of the scenarios is contained in Appendix 2.

These scenarios, implying either no or limited growth in transport petroleum usage contrast sharply with past trends. Fuel usage (gasoline and motor fuels) increased at an annual rate of 5.2% between 1965 and 1979 in Ontario. Therefore any scenario which differs so strongly from past trends, as these scenarios do, is bound to have a significant impact on the transport system, its usage, operations, growth potential and performance.

Although the projected energy availability for 2000 closely matches the 1980 consumption, it has been termed "constrained" since it is much less than would have been expected for 2000 based on past growth.

TABLE 1

ALTERNATIVE TRANSPORTATION ENERGY DEMAND SCENARIOS

FOR ONTARIO IN YEAR 2000

SCENARIO	ASSUMPTION	CONSUMPTION (10^{15} B.T.U.)
1	1980 Estimate	.570013
2	90% of 1980 Estimate	.513012
3	Equals population growth of 0.8% per annum	.667651

Source - Ministry of Energy, June, 1980

Note: Consumption is the transportation sector's petroleum usage only for year 2000.

3. ONTARIO'S CURRENT TRANSPORTATION DEMAND

The transportation system can be divided into 2 basic categories; passenger movements and goods movements. The aggregate demand for these is measured in terms of passenger miles and ton miles respectively. Although the unit of measure for usage per se is relatively simple and straight-forward, obtaining that actual measure of all transport usage within Ontario is not simple nor straight-forward, particularly for goods movement.

There are several reasons for this difficulty. Firstly there is fragmented responsibility for data collection between various levels of government. Secondly, some of the data is confidential. Lastly, the data collection programs are addressing issues other than the total transport usage, issues such as the volume of traffic on a particular section of a particular road, waterway or rail line. Therefore most estimates of total transport usage are derived measures, not direct measures and are subject to error.

There are very few estimates of total transport usage (passenger plus freight) on a provincial or national level in Canada. In 1976 a report entitled Transportation Energy Demand Analysis for Ontario was prepared by Canadian Resourcecon Limited for the Ministry of Energy in which estimates of Ontario's transport usage for the period 1955-1974 were prepared. Tables 2 and 3, based on the report, give the estimated passenger miles and freight ton miles, growth rates and market shares.

The automobile is the dominant mode for passenger usage accounting for approximately 90% of all passenger miles as shown on Table 2. The automobile passenger miles have increased at an annual rate of approximately 5%. Only the air passenger miles grew faster, at approximately 12% per annum. This high growth for air was reflected in several rapid developments, including air facilities, new commercial aircraft, declining real air fares and growth in disposable incomes. In the same period it is estimated that rail usage declined at a rate of approximately 2% per annum resulting in many rail routes being abandoned or receiving decreased frequency of service.

There are several interesting observations to be made for the general class freight. (Table 3A) First, rail has the largest share of the market. However, its share declined from 55% to 44% of the total between 1955 and 1974. Marine maintained its 26% share over time. The market share of intercity trucking grew from 18% to 30% of the

TABLE 2

1974 ONTARIO PASSENGER TRANSPORTATION DEMAND

IN BILLIONS OF PASSENGER MILES

Sector	Mode				
	Auto	Air	Bus	Rail & Subway	Total
Intercity					
Volume	30,828	1,534	863	894	34,119
% Total	90.4	4.5	2.5	2.6	
Growth Rate % cpa (1955-74)	4.3	12.8	3.1	-2.3	
Urban					
Volume	32,087		1,312	777	
% Total	93.9		3.8	2.2	
Growth Rate % cpa (1955-74)	5.5		-1.1	6.8	4.9
Total					
Volume	62,915	1,534	2,175	1,671	68,295
% Total	92.1	2.2	3.2	2.4	100

Note: cpa = Compound per annum.

Source:Canadian Resourcecon Limited, Transportation Energy Demand Analysis For Ontario, Volume 1, November, 1976.

TABLE 3 A

1974 GENERAL CLASS FREIGHT TRANSPORT DEMAND

IN MILLION TON-MILES IN ONTARIO[1]

Sector	Mode			
	Truck	Rail	Marine	Total
Intercity				
Volume	17,041	25,411	14,746	52,698
% Share	30	44	26	100
Growth Rate %[2] (1955-74 cpa)	9.5%	5.3%	6.4%	5.5%
Urban				
Volume	3,414			3,414
Growth Rate % (1955-74 cpa)	5.3%			
Total				
Volume	20,455	25,411	14,746	60,673
% Share	34	42	24	100

1) General Class Freight excludes bulk commodities of grain, coal, iron ore, forest products, natural gas and petroleum.

2) cpa = Compound per annum.

Source - Canadian Resourcecon Limited, Transportation Energy Demand Analysis For Ontario, Volume 1, November, 1976, Table III - 17, Table III - 44.

TABLE 3 B

FREIGHT OUTPUT AND MODAL SHARES
FOR SPECIFIC COMMODITIES
FOR ONTARIO, 1972

(000,00 ton miles)

Commodity	Output			Percentage	
	Rail	Marine	Total	Rail	Marine
Grain	7,235	17,098	24,333	30	70
Coal	229	4,153	4,374	5	95
Iron Ore	2,101	6,469	8,570	25	75
Forest Products	2,626	227	2,853	92	8
Total	12,191	27,947	40,130	30	70

Source: Transportation Energy Demand Analysis for Ontario, Volume 1, Canadian Resourcecon Ltd., 1976

market. Intercity trucking grew faster than any other form of goods movement averaging 9.5% per year over 20 years.

For bulk commodities (Table 3B) marine is favoured over rail by a significant margin as the principal mode of transport.

The Ministry of Energy, as part of its on-going activities, has prepared some simulations for the transport sector's energy consumption in 1980 as shown in Table 4. These forecasts estimate the automobile will consume about 57% of the energy used in transport for 1980. Trucking will be the second largest user with about 28% of the total energy. Rail has one of the smaller shares, consuming about 5% of the transport sector's energy. As well as these general highlights, the table shows the following:

- 56% truck consumption is urban oriented
- 65% auto consumption is urban oriented
- less than 1% of energy consumption is used in passenger rail.

The relatively large consumption of energy for automobile travel and trucking, implies that energy conservation efforts should focus on these modes, particularly in their urban application where the majority of energy is expended. For trucking, 56% of the fuel and only 17% of the production (ton miles) are urban oriented.

The Ministry of Transportation and Communications, through its Transportation Energy Management Program (TEMP) is studying the potential energy savings in urban transportation.[1] Several studies in Toronto, Hamilton and elsewhere are looking at specific measures that would reduce transportation energy consumption in Ontario's cities.

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[1] For further information see Transportation Energy Management Program, Phase III Project Sheets; Ministry of Transportation and Communications, Ministry of Energy, 1980.

TABLE 4

ESTIMATED 1980 ENERGY CONSUMPTION IN BTU x 10^{12}
FOR ONTARIO TRANSPORTATION

	Passenger		Freight			Total	
Mode	Intercity	Urban	General	Bulk	Urban	B.T.U.	% Share
Rail	2.23	.31	18.9	7.2		28.6	5.0
Bus	1.13	4.73				5.86	1.0
Air	34.6					34.6	6.2
Auto	109.4	195.5				308.9	56.3
Subway/ Streetcar		.63				.63	0.1
Truck			66.6		86.6	153.2	27.9
Marine			1.4	14.6		16.0	2.8
Total	147.2	205.2	86.9	21.8	86.6	547.7	
%	26.8	37.5	15.8	3.9	15.8		100

Source: Ministry of Energy

4 CHANGES IN TRANSPORTATION PRODUCTIVITY

The transportation system in Ontario is undergoing a series of changes which should result in a more energy efficient system. These changes are being achieved through both technological and operational changes within the various modes. Many of the changes are being made to reduce present and future operating costs. Some changes are the result of conditions or regulations imposed elsewhere such as those imposed on U.S. automobile manufacturers.

4 A. TECHNOLOGICAL CHANGES
PASSENGER SERVICES

The most profound changes in technology appear to be in the automobile sector. By 1985, the new vehicle fleet in the U.S.A. is to be achieving approximately 33 mpg compared to a 1975 new vehicle fleet average of 19-20 mpg for a theoretical increase in productivity of 65%. This is being achieved through smaller, lighter bodies, introduction of diesel engines, and various technical advancements. It has been speculated that the automobile fleet by year 2000 could be achieving over 50 mpg, for productivity increase of 150% over 1975 levels. Forecasts have indicated that diesel powered vehicles could make up as much as 25% of the vehicle fleet by that time.

With respect to alternative fuels, the recent Ontario Energy Review indicated "*some altenative fuels such as methanol, hydrogen and electricity for car and rail transportation will require long lead-times and high capital costs to bring them to the Ontario market. They are thus not expected to make a significant contribution to the Ontario transportation energy requirements before year 2000*".[1] For the purpose of this paper the Ministry of Energy indicated that transportation could be considered to remain highly dependent on petroleum.

Advances in rail technology will be made in Canada with the introduction of the L.R.C. train sets in the early 1980's. Some forecasters have assumed L.R.C. type trains will replace all existing rail passenger equipment by the year 2000 although only 10 train sets have been ordered to date. Using L.R.C. technology the available seat miles per gallon of fuel has been projected to increase from the current 80-89 to 250 for average 1978 rail operations[2].

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1 Ontario Energy Review, P. 45, Ministry of Energy, June, 1979

2 Transport Canada: Role of the Automobile Working Paper #23 - Trends In Use of Energy in Transportation, February, 1979.

This comparison should be treated with caution since the current average includes the energy expended in hauling ancillary service cars (diners, sleepers and baggage cars) and the L.R.C.'s will have a minimum of these service oriented cars in the train sets. No advances beyond the L.R.C. are seriously contemplated at this time for Canadian passenger usage.

Air transportation has been undergoing a series of changes in the last few years which has resulted in a decrease in the fuel consumed per passenger mile. With rising fuel costs, new aircraft with wing and engine advancements will decrease fuel consumption per seat mile. Some assessments have indicated potential productivity gains of up to 70% per passenger mile between 1980 and 2000[1] depending on the degree of new technology that is incorporated by year 2000.

The highway bus is currently the most energy effficient intercity passenger vehicle. However very little is expected over the next 20 years in terms of technical advancement that would dramatically increase its energy efficiency. The current (1975) and estimated (2000) efficiency and productivity for Canadian transport modes are shown on Tables 5 and 6 respectively.

FREIGHT SERVICES

From a review of current literature it would appear that less attention has been given to the possible technology advances in freight transportation compared to passenger transportation. Most advances are discussed in terms of particular commodities (grain, coal) and as a result particular segments of a mode (unit trains, specialized marine vessels). No broad estimates of potential gains in energy efficiency due to technical advancements in the freight sector can be given at this time.

4 B. OPERATIONAL CHANGES

PASSENGER SERVICES

There are several areas in which the operation of the automobile could be modified to increase its fuel productivity. These include enforcement of lower highway speed limits (80 & 90 km/h), fewer interruptions in urban areas (stop signs, turning vehicles) and higher load factors in urban areas, particularly for journeys to work.

VIA Rail is pursuing specific operational changes which will reduce operating costs and energy per passenger-km. These include adjusting train size and services to the expected loads. TATOA is also seeking

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[1] Transport Canada - Role of Automobile Study, Working Paper 23, Trends in Use of Energy in Transportation, February, 1979 Table 2.3

TABLE 5

ENERGY EFFICIENCY AND PRODUCTIVITY OF CANADIAN TRANSPORT MODES IN 1975

Mode	Btu per Available Seat Mile	Available Seat Miles per Gallon of Gasoline	Btu per Passenger Miles	Passenger Miles per Gallon of Gasoline	Assumed Load Factor
RAIL					
i) CN-CP Operation 1972-1975	1650-1900	80-90	3900-4400	35-40	39%
ii) Turbo Train (362 seats)	1000	150	2200	68	45%
iii) L.R.C. (520 seats)	610	250	1350	110	45%
AUTOMOBILE (50 m.p.h.)					
i) Fleet (5 seats)	1500	100	3100	48	48%
ii) Subcompact Fleet (4 seats)	1350	110	2800	53	50%
AIR					
Air Canada and CP Air	3450	43	5560	27	62%
BUS	580	260	1160	129	46%

Source: Role of the Automobile Study Working Paper #23.

TABLE 6
TRANSPORT VEHICLE ENERGY EFFICIENCY AND ESTIMATE OF PRODUCTIVITY IN YEAR 2000

			EFFICIENCY		PRODUCTIVITY	
Mode	Seats	Speed (cruise) mph	Btu per available seat mile	Seat Miles per gallon of gasoline	Passenger Miles per Gallon of Gasoline	Assumed Load Factor %
RAIL						
Modern light weight diesel (LRC) [a]	520	70-90	610	245	110	45
Gas Turbine [a]	144	125	813	183	82	45
Electric [b]	382	160	1110	134	60	45
Gas Turbine [b]	144	170	1300	115	52	45
BUS [c] (diesel)	45	50	580	257	129	45
Automobile Fleet [d]						
high technology scenario (39 mpg)	5	50	765	195	94	48
low technology scenario (32 mpg)	5	50	1165	158	77	48
Sub Compact Fleet						
high technology scenario (49 mpg)	4	50	761	196	98	50
low technology scenario (41 mpg)	4	50	910	164	82	50
AIR (1980) [e]						
most efficient use of existing and derived aircraft			2944	51	31.5	65
AIR (2000) [e]						
low technology scenario			2251	66	41	65
high technology scenario			1732	86	53.6	65

Source: Role of the Automobile Study, Working Paper #23

TABLE 6

SOURCES

a. *Representative of the most efficient operation of the L.R.C. train on existing track. Source:Office of the Director General of Railway Transportation M.O.T.*

b. *U.S. Transportation, Some Energy and Environmental Considerations 1972, W. Fraize, Mitre Corporation (Ref. 11)*

Note: These figures represent typical operating characteristics of new train technology. A more detailed description of new technology is provided in Appendix B.

c. *Fuel economy of 7 m.p.g., a 10% improvement since 1975.*

d. *High technology scenario assumes a significant market penetration of diesel, stratified charge engines, and a reduction in vehicle performance for all vehicles. Low technology scenario assumes less market penetration of diesel, and lower performance reductions. Complete details provided in Appendix A.*

e. *Assumes 15% improvement in fleet efficiency in 1980 due to higher density seating and "stretched" aircraft. Year 2000 fleet experiences the following increases in fuel efficiency.*

high technology scenario - 50% improvement over 1975 levels

low technology scenario - 35% improvement over 1975 levels

Sources: Possible Impacts of the Petroleum Shortages on Canadian Air Transportation
C.H. Glenn (Ref. 6)
Paper presented to the Institute of Combustion and Fuel Technology of Canada, Toronto, April 22, 1976

Transportation Vehicle Energy Intensities
A joint D.O.T./N.A.S.A. Reference Paper, 1974
R.L. Poulin, A.C. Masey. (Ref. 10)

operational changes which will increase the energy productivity for the GO Rail equipment. The changes include reducing deadhead mileage and diesel idling on some routes and adjusting train size in the off peak to suit demand on other routes. These steps would result in a fuel saving of 16% of the 1979 fuel consumption when fully implemented in the early 1980's.

Airlines are optimizing their operations by increasing passenger load factors, scheduling equipment to match passenger demand and improving maintenance programs in energy consuming components. Speeds have been reduced marginally on some flights. All major carriers are replacing older, less fuel efficient aircraft.

Significant savings in fuel consumption could be achieved by intercity bus carriers operating at lower speeds on selected routes. The current system wide fuel efficiency is approximately 7 miles per gallon for all intercity buses with an estimated load factor of 46%. However at 100 km/h the efficiency is estimated to be only 4.76 vehicle miles per gallon[1]. Reducing the cruising speed may result in a customer perceived lower level of service.

For all modes significant gains in energy productivity can be made by increasing the load factor. Both air and rail have had such gains in recent years, which means that the energy efficiency of these modes could be better than that indicated by the data in Table 6.

FREIGHT SERVICES

The trucking industry is pursuing various improvements designed to increase the fuel efficiency of their operations including the use of radial tires, wind deflectors and drag resistant trailers. Some operators have increased fuel economy from 5 to 9 mpg for line haul tractors[2]. Various productivity measures are shown on Tables 7A and 7B. The pressure to achieve greater efficiency will increase as fuel becomes an increasing share of the operating costs. However no firm estimate of the potential savings can be found in current literature.

The ratio of fuel costs to revenues for railways is the lowest amongst the major goods carriers (See Table 8). This low ratio, in part explains the delayed interest by the railways in energy efficiency measures. However a preliminary estimate suggests that a series of operational and technological changes as shown in Table 7C could potentially save a combined 20-30% of the fuel consumption. The changes include metered

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[1] N.D. Lea & Associates - Intercity Highway Passenger Transportation Sector. Technology, Efficiency and Productivity, 1975.

[2] Financial Post, Special Report, April 26, 1980.

TABLE 7A

TRUCKING PRODUCTIVITY

FUTURE POWER PLANTS AND THEIR IMPACTS

ENGINE TYPE	APPLICATION	ENGINE EFFICIENCY*	COMMENTS
MODIFIED GASOLINE ENGINE			
1) Lean Burn - reduce fuel to air mixture ratio.	-light to medium duty trucks	5-10% increase in economy	- currently under test in passenger cars.
2) Fuel Injection - careful monitoring of fuel-air mixture	- all vehicles	0-5% increase	- well proven in high powered autos.
3) Turbo Charging - uses exhaust gases to drive air compressor to generate more air for combustion.	- effective for short and long haul	10-20% increase	- increases output of engine so smaller engine can deliver power of a large one.
4) Stratified Charge - combustion takes place in two stages and allows lean mixture.	- all vehicles	5-10% increase	- tested in trucks and used in some autos.
ELECTRIC POWER	- short range pickup and delivery	10-20% increase in economy	- slow development of battery technology suggests limited application before 1990.
DIESEL ENGINE			
1) Dieselization with current technology	- all vehicles	25-40% increase in economy	- extensive use now in heavy large vehicles, light duty will be developed by 1980.
2) Improved Diesel Engines improved torque curves and turbo charging.	- short and long haul	10-20% increase over regular non-turbo charged diesels.	- under development.

* Improvement over gas engine.

Source: Interagency Study of Post 1980 Goals for Commerical Motor Vehicles - U.S. DOT and various technical articles.

TABLE 7B

TRUCKING PRODUCTIVITY

NON ENGINE TECHNOLOGICAL IMPROVEMENTS

Improvement	Pickup and Delivery Operations	Intercity Operations	Comments
1) Lubricants decrease drive train friction losses.	1-2% improvement in efficiency.	1-3% improvement.	Used in engine and drive line.
2) Engine Accessories temperature controlled cooling fans.	3-6% increase in economy.	5-8% increase in economy.	
3) Radial Tires	3-5%	6-10%	
4) Automatic Transmission	3-5%		Applies only to local operations.
5) Improved Aerodynamics		7-12%	Primarily add on devices at low end and redesign at high end.
6) Matching Transmission and Drivelines to Needs		2-5%	
7) Reduction in Tare	2-5%	5-7%	10% reduction in tare is possible by 1985

Source: "Interagency Study of Post 1980 Goals for Commercial Motor Vehicles", U.S. DOT.

TABLE 7C

RAIL ENERGY CONSERVATION OPPORTUNITIES

	Potential Saving
Operational Opportunities	
Reduce Locomotive Idling	4%
Reduce Fuel Spillage	0.5%
Improve Train Handling	1%
Improve Consist Makeup	1%
Reduce Operating Speeds	1-5%
Increase Net to Gross Shipping Ratio	?
Technological Opportunities	
Streamlining	2%
Reduce Tare Weight of Cars	1-6%
Locomotive Improvements	3-5%
Steerable Trucks	2%
Infrastructure Improvements	
Concrete Ties	1%
Gradient Modifications	?
Double Tracking	?
Total Potential	16-28%

Source: Canadian Institute for Guided Ground Transportation
Canadian Railway Energy Conservation and Alternative Fuels
78-13, Queen's University

TABLE 8

RELATIVE ENERGY COSTS FOR INTERCITY TRAVEL

Passenger Modes (Canada)	% Energy Cost / Total Cost
Auto	20
Bus	9
Rail	6
Air	19

Freight Modes (U.S.)[1]	% Energy Cost / Total Revenue	January, 1979
Truck	14	
Rail	8	
Marine (Barge)	34	

Notes

1 D.S. Paxson, The Energy Crisis and Intermodal Competition Association of American Railroads, January, 1980.

refueling, reduced idling, improved train control and improved consist make-up. Many of these changes will require further studies before being implemented by the railways. Some of the changes such as reduced speed may in some cases lower the level of service to the customer.

At present there appears to be little documentation of operational changes which would improve the fuel efficiency of Ontario's marine fleet. One reference indicates some operators are contemplating reverting some of their vessels to coal from oil in light of rising costs[1].

4 C. PRODUCTIVITY OVERVIEW

In viewing the energy efficiency of the transport system for both passengers and freight, there is a tendency to view each mode in isolation. But the maximizing of productivity for each mode does not necessarily maximize the productivity of the entire system. There is an interaction of the various components through both service and financial factors.

The documenting of this interaction, particularly as it relates to energy is a difficult task. There appears to be no clear agreement as to the relative efficiency of various modes. Each situation, for either passenger or freight would appear to require an individual analysis to obtain conclusive results. Such an individual analysis is however, beyond the scope of this paper.

The next section will therefore be limited to a broad overview of how the transportation modes may perform under the various postulated scenarios for petroleum energy availability by year 2000.

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[1] Financial Post, Special Report, April 26, 1980.

5 SYSTEM PERFORMANCE UNDER ENERGY CONSTRAINTS

5A THE APPROACH

To illustrate the possible performance of the transportation system under the various given energy constraints a selective approach will be used. The approach will look at intercity passenger transportation, a sector which is multimodal in outlook but dominated by the automobile. This will provide some insight into the role that rail could or would have to play under the given energy constraints. There is also sufficient data available to speculate as to the growth rates in intercity passenger travel by various modes up to the year 2000. In addition to reviewing the intercity passenger sector, other sectors will be studied in a cursory manner to highlight significant points.

5B RELATIVE ENERGY USAGE FOR INTERCITY PASSENGER MODES

One basic concern is what would be the relative energy usage by each intercity passenger mode in the future (year 2000) as compared to the present situation. As previously shown, the automobile is the dominant mode. But what role would it, and the other modes, have to assume under an energy constrained situation?

An approach, outlined in the following 5 steps, was devised to look at potential energy shares for each scenario.

a) Establish the 1980 relative share of travel and relative share of energy for each intercity mode;

b) Establish a range of the productivity improvements in terms of fuel usage that could conceivably be implemented in each mode by the year 2000;

c) Estimate the potential growth in each mode, based on population, income and fuel availability;

d) Based on changes in energy productivity and growth in travel, establish an estimate of the energy use for year 2000 relative to 1980;

e) Repeat the process (steps b, c and d), varying the growth rates in travel and the changes in productivity until the resulting year 2000 energy usage matches the given year 2000 scenario.

This five step process yields information on the possible relative energy usage by year 2000 for intercity passenger modes. The process is highly arbitrary (in selecting growth rates and productivity gains) but it quickly and simply can assess the types of relative change needed in a transportation system to achieve certain energy targets. The details of the process application are outlined in the following sections.

For each intercity passenger mode, the estimated 1980 share of travel and share of energy (step 'a' above) are summarized in Table 9. The auto has the largest share of passenger miles and energy usage followed by the air mode. Rail and bus have minimal shares of both travel and energy usage.

Table 10 summarizes the average productivity for 1980 in terms of load factor and passenger miles per gallon (step b). A range of changes in such factors is also included to provide estimates of modal productivity to the year 2000. Most significant advances in productivity are forecast to occur in the auto and air modes. Although rail will see improvements with the introduction of the LRC equipment, the application will be restricted to only a few routes. In part these estimates of productivity increases could be considered conservative since either no or marginal changes are forecast for the respective load factors during this part of the exercise.

The relative growth in travel for each mode was estimated after reviewing several different forecasting exercises (step c). The reviewed studies include the Role of the Automobile (T.C.), the Southern Ontario Multimodal Passenger Studies (T.C./M.T.C.), Energy Conservation in Intercity Passenger Transportation: The Windsor Quebec City Corridor (B.M.C.) and Technology Assessment of Changes in the Future Use and Characteristics of Automobile Transportation System (U.S. D.O.T.) In each of these studies lower growth rates in travel corresponded to lower projections of energy availability. In other words, most studies have projected that the fuel constraints would depress the total demand for travel instead of merely shifting demand

TABLE 9

1975 MARKET SHARE AND ENERGY USAGE
FOR INTERCITY PASSENGER TRANSPORT
WITHIN CANADA

Mode	Market Share % Pass.-Mile	Energy Share % BTU
Auto	80	68
Air	16	27
Rail	1	4
Bus	3	1

Source: Role of the Automobile Study.

TABLE 10

1980 AND 2000 ENERGY PRODUCTIVITY
FOR INTERCITY TRANSPORTATION

Mode	1980 Productivity		2000 Productivity			
	Load Factor %	Passenger Miles/Gallon	Load Factor %	Seat Miles Gallon	Passenger Miles Gallon	% Change $\frac{2000}{1980}$
Auto						
Scenario 1	50	48	50	160	80	65
Scenario 2	50	48	50	172	86	80
Scenario 3	50	48	50	140	70	46
Air						
Scenario 1	62	27	65	86	54	100
Scenario 2	62	27	65	86	54	100
Scenario 3	62	27	65	66	42	52
Rail						
Scenario 1	39	40	45	245	110	175
Scenario 2	39	40	45	245	110	175
Scenario 3	39	40	45	245	110	175
Bus						
Scenario 1	46	130	45	257	130	0
Scenario 2	46	130	45	257	130	0
Scenario 3	46	130	45	257	130	0

Source: Adapted From Tables 5 and 6

to alternate modes. This appears to be a reasonable assumption since much of the intercity travel is discretionary in nature (i.e. visiting and other pleasure accounted for 57% of intercity household trips in Ontario[1]). Since there is reasonable agreement between the above independent assessments of potential growth by mode , growth rates for this exercise were taken to be in the same range. Three growth rates for each mode were established, based subjectively on the energy availability for each scenario.

The projected growth rates are shown in Table 11. In all cases, the future growth in travel is projected to be considerably less than has been experienced in the past for the auto and air modes. The lower growth projection in travel is a result of lower population growth, lower growth in incomes, changing population age structure and increasing concerns related to energy including its cost. It should be noted that the estimates of future growth in rail usage are perhaps subject to more uncertainties than those for the other modes because of the past growth trends (see Table 2).

The estimate of the year 2000 relative energy shares, for each scenario, is based on the 1980 relative energy share, the growth in travel and changes in modal productivity, as shown in Table 12. This process was reiterated (step 'd' and 'e') changing the growth rates and productivity until the year 2000 relative energy matched and given scenarios.

The above example shows the relationship between the postulated energy availability scenarios and the consumption of intercity passenger transportation under various assumptions of travel growth and productivity improvements.

It should be noted that although the assumed gains in modal productivity are substantial, they nevertheless can be considered to be realistically achievable. Some cases, such as the auto fuel economy standards, may require a government order to be achievable.

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[1] Appendix to Report on June 1977 Travel Study, Transport Canada.

TABLE 11

SELECTED GROWTH RATES IN INTERCITY PASSENGER TRAVEL
DEMAND FOR 3 ENERGY CONSTRAINED SCENARIOS

Mode	Scenario 1 2000 = 1980	Scenario 2 2000 = 90% 1980	Scenario 3 2000 = 1980 + 17%
Auto			
Growth Rate %	2.25%	2.0%	2.5%
20 Yr. Factor	1.56	1.50	1.64
Air			
Growth Rate %	4.5	3.5	4.5
20 Yr. Factor	2.41	2.00	2.41
Rail			
Growth Rate %	2.0	4.0	1.0
20 Yr. Factor	1.50	2.20	1.22
Bus			
Growth Rate %	2.5	2.0	2.5
20 Yr. Factor	1.64	1.50	1.63
Total			
Growth Rate %	2.7	2.3	2.85
20 Yr. Factor	1.70	1.57	1.75

TABLE 12

RELATIVE CHANGE IN ENERGY CONSUMPTION
1980-2000 FOR 3 ENERGY CONSTRAINED SCENARIOS

Scenario	Mode	1980 Energy Share (Table 9)	x	Travel Growth (Table 11)	x	1 / Productivity Change (Table 10)	=	Relative 2000 Energy Share
Scenario 1								
= 1980	Auto	68		1.56		0.606		64
	Air	27		2.41		0.500		32.1
	Bus	1		1.64		1.00		1.6
	Rail	4		1.50		0.364		2.2
		100%						100%
Scenario 2								
= .9 x 1980								
	Auto	68		1.50		0.55		58
	Air	27		2.00		0.500		27
	Bus	1		1.50		1.00		1.5
	Rail	4		2.20		0.364		3.2
		100%						90%
Scenario 3								
= 1.17 x 1980								
	Auto	68		1.64		0.64		71
	Air	27		2.41		0.65		43
	Bus	1		1.63		1.00		2
	Rail	4		1.22		0.364		2
		100%						117%

Further improvements in the productivity could be achieved by higher load factors, especially in the public modes (air, bus and rail). But the illustration has not directly addressed transport demand and the potential for modal shift, only energy demand.

5C CHANGES IN TRAVEL DEMAND

To assess the role of rail under an energy constrained situation it is necessary first to have some estimate of the future passenger demand by mode then assess the potential for modal diversion to the more efficient modes.

This assessment was prepared using the following approach.

a) Establish the 1980 passenger miles by intercity mode for Ontario;

b) Using the previously estimated productivity changes (Table 10) and growth rates by mode, (Table 11), establish the year 2000 passenger miles for each of the 3 energy scenarios;

c) Using the total passenger miles from the most plentiful energy scenario (2000 = 1980 + 17%), estimate the changes in modal shares required to achieve the more stringent energy targets (2000 = 1980 - 10%).

The resulting travel demand for each scenario is shown on Table 13, for Canadian intercity travel. It was assumed that Ontario's characteristics would be similar to the Canadian, for purposes of this exercise. For the automobile, two demand estimates are presented, the first represents all intercity trips greater than 25 miles (40 Km) and the second represents those greater than 100 miles (160 Km). As shown on Table 13, scenario 2 (-10% less energy) has the least demand, and Scenario 3 (17% more energy) has the greatest demand. However the difference in terms of annual travel growth is minimal (2.3% vs. 2.85%) especially when viewed in terms of past growth rates.

TABLE 13

CANADIAN TRAVEL FORECAST FOR 1975-2000

FOR 3 ENERGY SCENARIOS

	1975	Scenario 1 (N.C.)		Scenario 2 (-10%)		Scenario 3 (+ 17%)	
	BPM (a)	G.R. (b)	B.P.M.	G.R.	B.P.M.	G.R.	B.P.M.
Auto (25) (c)	95	2.25	165	2.0	158	2.5	176
(100) (d)	60		105		98		111
Bus (25)	4.1	2.5	7.6	2.0	6.7	25	7.6
(100)	2.6		4.8		4.3		4.8
Rail	1.7	2.0	2.8	4.0	4.5	0	1.7
Air	19	4.5	57	3.5	45	45	57
Total (25)	119.8	2.7	232	2.3	214	2.85	242
(100)	83.3	2.9	170	2.4	151	3.00	174.5

Source: 1975 obtained from the Role of the Automobile Study.

a) BPM: Billion Passenger Miles
b) G.R.: Annual Growth Rate for the period 1975-2000.
c) All auto trips greater than 25 miles.
d) All auto trips greater than 100 miles.

The assessment of modal shift reviewed the necessary diversion from auto and air, under conditions of minimum fuel availability (Scenario 2) necessary to satisfy the total travel demand forecast under the maximum availability scenario, (Scenatio 3). This assessment shown in Table 14, assumes the upper demand to be fixed (i.e. it must be accommodated) regardless of external factors.

Table 14 has assumed bus and rail would both play a significant role in an energy constrained future if demand were to be diverted away from the auto and air. A similar exercise could be repeated for rail only but it is unlikely that rail would be the sole beneficiary due to its limited coverage, limited flexibility and large cost to government compared to the privately funded, highly flexible, low cost intercity bus.

Table 14 compares the modal shares of travel for two variations of Scenario 2 (Constrained Demand of 214 billion passenger miles and Full Demand of 243 billion passenger miles) and Scenario 3 (243 billion passenger miles). The growth rates for Scenario 2 (Constrained Demand) and Scenario 3 were obtained directly from Table 13. The growth rates for Scenario 2 (Full Demand) were derived in an iterative fashion, lowering growth rates for the auto and air, and raising the growth rates for rail and bus while keeping the total demand fixed at 243 billion passenger miles. The result is one possible illustration of modal shares and growth rates for demand under various energy futures.

The illustration has shown that for a given level of energy availability differing demands can be accommodated depending on the modal split and modal growth rates. If the maximum demand is to be accommodated as well as a lower energy availability target, both bus and rail would have to assume a much laxger role than they presently do.

TABLE 14

RELATIVE GROWTH & MODAL SHARES 1975-2000
FOR CANADIAN INTERCITY TRAVEL

	1975		Scenario 2						Scenario 3		
			Constrained Demand			Full Demand					
Mode	B.P.M(a)	% Total Mileage	G.R.(b)	B.P.M.	% Total	G.R.	B.P.M.	% Total	G.R.	B.P.M.	% Total
Auto	95	79	2.0	158	74	1.6	141	59	2.5	176	73
Bus	4.1	3	2.0	6.7	3	10	44	18	2.5	7.6	3
Rail	1.7	1	4.0	4.5	2	10	18	7	1.0	2.1	1
Air	19	16	3.5	45	21	3.0	40	16	4.5	57	24
Total	120	100	2.3	214	100	2.85	243	100	2.85	243	100

BPM - Billion Passenger Miles

G.R. - Annual Growth Rate for the period 1975-2000

Table 14 has shown that to achieve a 10% reduction in energy usage and maintain a relatively high rate of growth the following are necessary.

- auto share of travel to decrease from 89% in 1975 to 59% of the passenger miles by 2000, (a 30% drop);
- air mode could retain its basic mode share in terms of passenger miles if productivity gains are made;
- the use of both rail and bus would have to increase tenfold from 1975 levels, which is equivalent to an annual compounded growth of 10% per annum for 25 years.

Under these conditions the automobile would be experiencing very low growth (1.6% per year) compared to all past experience and rail and bus would have unusually high growth rates sustained over a long term.

A similar energy target (10% reduction from 1980 level) and constrained growth in travel (12% reduction from high year 2000 estimate) could be accommodated as shown in Table 14 (Scenario 2 Constrained Demand) in the following manner:

- the auto share of travel is reduced to 74% of the total;
- the air share of travel increases 5% to 21% of the total;
- the rail share increases by 1% to 2% of the total
- the bus share remains the same at 3%.

The major difference in these alternatives is the amount of intercity automobile and air travel that is accommodated.

Under conditions of moderate expansion of fuel supply (Scenario 3), if the auto and air demand where dampened the growth in rail and bus would follow historical patterns,

as shown on Table 14. The auto's share of the total market would decrease, air would increase and bus would maintain its historic share for the travel market.

Table 14 is an illustration of providing accessibility under the postulated energy constraints. It shows the theoretical role of rail could vary, from maintaining its present ridership to accommodating a tenfold or more growth in ridership. Currently rail has such a small share of the intercity passenger market that a 2% diversion of auto users to rail represents a 100% increase in rail usage. The 2% diversion may appear very small in terms of auto usage but would almost overwhelm the rail system. Due to these differences, it is very difficult to define a realistic level of expectation for rail usage.

This exercise has shown examples of representative compositions of intercity passenger travel that would be required to respond to limited energy supplies, assuming that the sector achieved the same proportion of transport energy in year 2000 as it does in 1980. For one reason or another, it may be decided that this sector has less priority in the future than at present in terms of energy supply. If that were to be, the above exercise could be repeated and the new implications determined.

5D OTHER TRANSPORT SECTORS AND MODES

Although there is adequate documentation of the current modal usage and energy shares for the freight and urban passenger sectors there is very little information available on which assessments of the future conditions could be based.

INTERCITY FREIGHT

For the freight sector, there is a lack of information concerning possible growth rates or productivity improvements.[1] Some historical growth rates are provided on Table 3 for 3 freight modes. For specific traffic such as Container on Flat Car (COFC) or Trailer on Flat Car (TOFC), growth rates over a more limited period are provided in Table 15. The growth

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[1] The Future of The Truck and Rail Modes as Carriers, Wolff and Kuczer, 1979, forecast the total freight market would grow by no more than 4% per year between 1980 and 2000.

TABLE 15

SUMMARY OF TRAILER-ON FLATCAR AND
CONTAINER-ON FLATCAR MOVEMENTS IN CANADA
1972-1977

	Trailer-on Flatcar			Container-on Flatcar		
Year	Tons	Percentage Change	Percentage of Total Carloads	Tons	Percent-age Change	Percentage of Total Carloads
1972	4,004,189		1.68	3,258,857		1.37
1973	4,103,060	2.47	1.54	3,886,810	19.3	1.46
1974	4,666,197	13.72	1.70	4,481,320	15.3	1.63
1975	4,730,225	1.37	1.88	4,335,757	-3.2	1.72
1976	5,419,592	14.45	2.05	4,601,120	6.1	1.74
1977	5,666,392	4.55	2.17	5,541,076	20.4	2.03

Source: Statistics Canada, Railway Carloading, Cat. No. 52.001

in these two categories has been faster than for rail in general, but similar to growth in intercity trucking, indicating that COFC and TOFC are generally competitive with trucking. No forecasts of the potential diversion from trucking to rail or vice versa for this class of traffic has been found. The potential diversion to rail from trucking however is believed to be limited by several factors. The average COFC or TOFC trip length is several times the average intercity truck trip, indicating only a small part of the total trucking movements could be readily transferred. Secondly, as the average trip length by rail decreases, the energy efficiency of rail also decreases until it is less than the energy efficiency of intercity trucking for door to door movements as shown in Table 16 for a U.S.A. situation.

Trucking in the freight sector, has had advantages over rail similar to those that the auto has in the passenger sector, it can offer complete non-stop door to door service, as well as multi stop service, route flexibility, greater area coverage and reliable schedules. It is ideally suited to the needs of high value low volume materials. However on long haul trips trucking suffers from increasing fuel costs. Rail transport on the other hand is suited to the needs of high volume, low value materials, such as the bulk commodities (grain, coal, iron ore) being transported over long distances. In 1977 the average mileage haul by all railways was 860 Km. The role of trucking will increase in areas where rail branch lines are being closed and abandoned.

One recent study concluded that the total freight would grow at about 3.5% per year[1]. But the share held by rail and trucking depended directly on assumptions made about technological innovation within the mode, the economic growth particularly in the key sectors and energy pricing and availability. There was no assurance that freight would divert to rail from truck under all conditions.

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1. The Future of Truck and Rail Modes as Carriers of Freight in Canada R. Wolff and C. Kuczer, University of Toronto, York University Joint Program, 1979.

TABLE 16

U.S. EXPERIENCE

RELATIVE ENERGY EFFICIENCY: RAIL VS TRUCK VS BARGE

SERVICE TYPE (NET TONS PER VEHICLE)	PERCENT LOADED MILES a/	NET TON-MILES PER GAL. b/	ENERGY EFFICIENCY RAIL TO TRUCK c/	ENERGY EFFICIENCY RAIL TO BARGE d/
Unit Train Service (100 Tons)	50%	350		
			4.4 to 1	
Truck (25 Tons)	50%	69		
				1.5 to 1
Barge - Inland Waterway		277		
Rail Carload Service (45 Tons)	60%	198		
			2.2. to 1	
Truck (20 Tons)	80%	77		
Long Haul TOFC Service (30 Tons)	75%	172		
			2.3 to 1	
Truck (15 Tons)	85%	64		
Short-Haul TOFC Service (40 Tons)	65%	97		
			1.6 to 1	
Truck (15 Tons)	70%	54		
Local Service (45 Tons)	55%	40		
			0.6 to 1	
Truck (20 Tons)	60%	61		

a/ These are typical for service types mentioned.
b/ Rail - Various sources. Truck - Various sources.
Barge - Peat, Marwick, Mitchell & Co., Industrial Energy Studies of Ground Freight Transportation, for U.S. Department of Commerce, 1974.
c/ Adjusted for rail circuity - 1.17% of truck.
d/ Adjusted for barge circuity - 1.60% of rail.

Source: D.S. Paxson, The Energy Crisis and Intermodal Competition Association of American Railroads, January, 1980.

URBAN PASSENGER TRANSPORTATION

Within the urban transportation sector, the automobile is the dominant mode for all trip purposes due to its flexibility and availability. Commuter rail will continue to play a key role in the journey to work for downtown Toronto but its growth over the next ten years will be limited, according to a recent review completed by Dr. Soberman for M.T.C.[1] It was identified that the commuter rail system does have some flexibilitity to accommodate increased ridership which might divert from autos in an energy shortage situation.

Finally, the public transit systems throughout Ontario do have excess capacity at present to accommodate future growth. No major gains in energy productivity were foreseen for public transit.

5E SYSTEM PERFORMANCE SUMMARY

In summary, for both freight and passenger transportation there are several data deficiencies which prevent a detailed analysis of a year 2000 scenario under various energy situations. However the available data does show that rail does have a limited potential to play a greater role under the suggested energy constraints. It would be expected that the railways would be monitoring the transportation system, in an effort to increase their market shares particularly where they have excess capacity in terms of trackage and equipment. Any government initiated moves to encourage significantly greater use of rail transport would most likely need to be supported by significant public capital and operating expenditures based on current experience.

---

[1] Reassessment of Commuter Transit Needs in the Toronto Region - Dr. Soberman, University of Toronto, York University Joint Program 1980.

6 SUMMARY

An Approach to Energy Conservation

The objective of this report has been to assess the capability of the transportation system to respond to a range of energy futures postulated by the Ministry of Energy. The energy futures basically indicate no significant change in the rate of petroleum supply between now and year 2000. The Ministry of Energy, both in reports and discussions have indicated that alternate fuels will not play a significant role in the transportation system by the year 2000.

The automobile is the overwhelming favourite mode for passenger transportation accounting for approximately 90% of all passenger miles. Also it is the largest user of petroleum in the transportation sector, consuming approximately 60% of the total transportation usage for 1980. Therefore any strategy to deal with limited petroleum energy supplies must deal with the automobile. This can be accomplished in 3 basic ways; improving productivity, altering demand and encouraging the use of alternative forms of travel. It has been illustrated that the various energy constraints could be met by various combinations of the 3 basic ways.

First the energy constraints could be met in part by improving the productivity of all modes, and the automobile in particular. The productivity is being increased through energy efficient new designs including lighter, smaller vehicles, improving technology etc. But these changes are very costly. Greater productivity can also be achieved, at a lower cost, by raising the load factor for the urban automobile and all public modes.

Growth rates in travel must be less than has been experienced in the past, particularly for the automobile and air mode. It would be virtually impossible to have no growth in petroleum consumption at the same time as having a 5% per annum increase in automobile usage or a 12% per annum increase in air usage. The growth rates for travel in the future are expected to be less than in the past for several reasons, including the rising energy costs and projected lower population gowth rate. Various government agencies should monitor the growth in travel and explore ways and means of modifying the growth rate, as required in the future.

Finally, diversions from the automobile and air to both rail and bus would contribute towards accommodating travel under energy constraints, particularly in high density corridors where there is sufficient demand to warrant high frequencies and achieve high load factors. With an aging population, and rising costs of auto operations, the public modes should be able to serve more recreational trips. Recently VIA has experienced a significant increase in the use of its packaged holiday tours and this trend is expected to continue.

The intercity bus also has the potential to increase its market share of intercity passengers in an energy conserving future. With appropriate government influence, the privately operated bus industry would be capable of accommodating an increased demand without direct subsidies similar to those currently paid for passenger rail services.

Therefore for intercity passenger travel it would appear that in an energy constrained situation, it would be most useful to pursue the following strategies, in order of importance:

- increase productivity of all modes;
- reduce the rate of traffic growth, particularly for the automobile and air modes;
- divert the compatible traffic from the automobile and air unto the rail and bus.

The Role of Rail Transportation

Currently, rail has about 1% of the intercity passenger market and even less of the urban passenger market. Defining its appropriate market share in an energy constrained future is problematic. Is rail capable in terms of equipment, facilities and capital to sustain a 10% or 15% growth per annum over 20 years? It is these growth rates that are necessary if rail is to be a significant mode in an energy conserving future. Currently the passenger market share held by rail is so small that even a 2% decrease in intercity auto usage means a 100% increase for rail. This clearly indicates that in order to accommodate a significant reduction in auto usage through shifts of passengers to rail, significant investments in rail equipment and infrastructure would be required. Based on recent experience

much of the new investments would likely be funded by government. Furthermore many of the travel characteristics of auto users are significantly different than rail users, which indicates that there are limitations to the degree that shifts from auto to rail can take place. For the urban passenger sector, commuter rail has the capability to handle more passengers, however, its potential to increase its ridership is somewhat limited by a variety of factors, including its concentration on downtown oriented travel.

In the freight sector, rail has several positive features which will assist in playing a larger role. It has the lowest fuel cost to revenue ratio for freight transport. In Ontario it generally has adequate infrastructure and spare capacity. However rail is not the most efficient way of moving all shipments door to door. Many small volume, short distance movements would be better accommodated by trucking both in terms of energy and customer service. Rail companies would presumably monitor the changing energy situation and attempt to capture a greater share of specialized markets by offering competitive services and prices.

Given the appropriate set of conditions in terms of government policies, economics, energy and technological innovation, rail could play a larger role in the freight and passenger sectors.

Outstanding Concerns

In summary, with the appropriate multimodal strategies, the transportation system could be made to respond, in the long term, to energy constraints by pursuing productivity gains, reducing demand and selectively shifting some demand. However this response will require time, effort and money, both from the private and public sectors.

It should be emphasized that this report has shown some of the end results needed if the transportation is to be capable of accommodating future needs under postulated energy constraints. It has not addressed how these results are to be achieved, at what expense, with what success and what impact. Reshaping the transportation system for the future will not be simple for many reasons.

Travellers and shippers use a particular mode of travel for very

distinct reasons. These reasons are not likely to readily change. Air users value speed, auto and truck users value the flexibility and perceived low cost of these modes, rail users cite rail's comfort. Studies in the Windsor-Quebec City corridor have found the most significant attributes to a traveller for choosing a mode of transport to include:

- on time reliability
- departure times
- total door to door travel time
- terminal convenience and
- transportation cost.

As well as these attributes, travellers have distinct and often negative impressions of certain modes in terms of cleanliness, comfort, safety, quality of ride and on-board services. In very few cases are the attributes of one mode equal to another. Studies have also shown the travellers themselves have very distinct characteristics which influence the choice of a travel mode including:

- the trip purpose (business, recreational, social)
- trip distance (longer trips prefer air)
- income level
- party size and
- household location (city, suburban, rural).

Given the distinct attributes of each mode and the potential variation in traveller characteristics of each mode, significant modal shifts are not likely unless either the attributes, perceptions or traveller characteristics also change significantly.

Changes are expected in the future transportation system. The changes will be made, in part, for energy conservation and in part for other reasons including public perceptions, economics of operations and government priorities. As a result of these changes, rail will likely have a larger role, but not a universal or all encompassing role. Any significant role would be limited to corridors of relativity, high density and where the majority of travel would be destined to centres located on the rail line, such as in the Windsor-Quebec City corridor. This market however, represents a small part of all intercity travel.

The most appropriate type of energy conservation measures will range from one application to another, depending on the presence of alternative modes, the origin and destination of travel, the trip purpose, the traveller or commodity characteristics. The effectiveness and feasibility of each conservation measure therefore will have to be assessed for each specific application before adopting any strategy. Many experts in energy conservation have concluded the appropriate way to reduce petroleum consumption will involve implementing many diverse and often small measures each suited to a specific application.

Finally, this report has been based on the postulated petroleum energy scenarios from the Ministry of Energy and on the available aggregate travel data. In future, the energy scenarios should be refined to include the role, the timing and the cost for alternative fuels as well as expanding on the given petroleum scenarios. The aggregate travel data has several deficiencies, including its age, incompleteness and generalizations. Detailed travel data would be requied for assessing the role of rail in individual situations. Relatively very little attention has been given to the freight sector, its growth and potential for productivity increases. Based on some of these needs, this report should be viewed as an initial attempt to qualify some of the questions raised by the Ontario Task Force on Provincial Rail Policy.

APPENDIX 1

TERMS OF REFERENCE

FOR THE

IMPACT OF AVAILABILITY OF ENERGY RESORUCES

ON TRANSPORTATION IN ONTARIO

TASK: Availability of energy resources

PURPOSE: To identify future energy resource availability and its effect on transportation in general and rail transport in particular.

OUTPUT REQUIRED:

- A comparison table showing the energy use characteristics of all modes of both passenger and freight transportation.
- A table showing the existing percentage of total energy comsuption in Ontario assigned to transportation with a further breakdown by mode of transportation.
- A description of the existing and future (30 years) availability of energy resources in Ontario by type (i.e. nuclear, hydro-electric, oil, methanol, hydrogen, etc.)
- A perspective on the impact that this availability (or lack) of certain energy sources will have on transportation in the future:
  - what effect will it have on shifts to different modes of both passenger and freight transportation? (i.e. will rail's role increase because of energy consideration).
  - what effect will it have on total transportation requirements e.g. will fewer passenger trips be taken with a greater reliance on communications.

TO BE ASSIGNED TO:

Ministry of Energy

(Note: task description will be further modified and amplified in discussion with person(s) assigned to.)

APPENDIX 2

MINISTRY OF ENERGY

BACKGROUND TO

ALTERNATIVE ENERGY SCENARIOS

Ontario

Ministry of Energy

Telex
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June 11, 1980

MEMORANDUM TO: J. Parviainen
Urban and Regional Transportation Planning Office
Ministry of Transportation and Communications

FROM: Dean Mountain
Strategic Planning and Analysis Group

SUBJECT: Construction of Alternative Transportation Energy Demand Scenarios

---

With regard to Bunli Yang's letter of May 28, I am furnishing you with the following figures concerning oil consumption in the transportation sector.

	Consumption (10^{15} B.T.U.)
1980 estimate	.570013
90% of 1980 estimate	.513012
population growth of .8% per annum	.667651

Based on our assumptions about disposable income population increases, urbanization assumption and the amount of time people spend driving in an urban versus inter-city setting, we have made the following estimates:

	Passenger Miles Urban/Inter-City
1976	.960
1980	.958
1985	.946
1990	.934
1995	.929
2000	.922

Dean Mountain

cc: Dennis Callan

DCM/sz

7540-1021

SEND TO: Dean Mountain
cc. K Sharratt / J. Parviainen, MTC

FROM: B. Yang

DEPT.

DATE: May 28, 1980

SUBJECT: Rail Task Force Request

Following our presentation of May 7 and the seminar on May 14-15, the Task Force has asked us to supply the items on the attached sheet. No timing has been set, but June 6 should be OK, To Dennis Callan (5-0445). My comments on the items

1. We should supply the assumptions on the efficiency tables in our presentation.
2. Already done.
3. Not desirable. But 3 single-pt. (say 2000) scenarios at least for oil might be illustrative:
   - A. Same amount of oil for transportation as in 1980
   - B. Increase in oil for transportation growing with population, say 1.8% per annum.
   - C. Reduction in oil for transportation, from 1980 levels. Perhaps 10%?
4. MTC are best qualified to comment on and provide guesses on total transportation

REPLY

services, modal splits, etc. based on the 3 single-pt., year 2000 oil scenarios.
Please co-ordinate with MTC; D. Callan is contacting MTC directly as well.

Bruce

REPLY FROM

REPLY DATE

Assumptions

Initial (1979) Assumptions

- The light fuel oil price is a Toronto price.
- The natural gas prices are Ontario averages of the last three months of residential, commercial and industrial prices of 1979.
- The residential electricity price is the tail end rate for North York.
- The industrial and commercial electricity prices are Ontario averages.

Case I

- Electricity prices increase at 1% real.
- International crude oil prices are $35 U.S. 1979 (f.o.b. Persian Gulf) by 2000. Canadian prices will be at world levels by 1986.
- Residual oil is priced at 92.3% of the crude oil prices.
- Natural gas prices (on a BTU equivalency basis) will be 85% of crude oil prices by 1985, 90% by 1990 and 100% by 1995.
- All distribution margins escalate at the rates of inflation which are:

1979-85	8.16%
1986-90	6.62%
1991-2000	6.88%

Case II

- Electricity prices increase at 1% real
- International crude oil prices are $55 U.S. 1979 (f.o.b. Persian Gulf) by 2000. Canadian prices will be 85% of those at world levels by 1986 and remain at 85% thereafter.
- Residual oil is priced at 92.3% of the crude oil price.
- Natural gas prices (on a BTU equivalency basis) will remain at 85% throughout the time period.
- All distribution margins escalate at the rates of inflation which are:

1979-85	8.26%
1986-90	6.77%
1991-2000	7.03%

Ontario Light Fuel Oil Prices ($ per gallon)
Residential, Commercial and Industrial

Case I (Low Oil Price Scenario)

	Real (1979 $)	Current
1979	.703	.703
1980	.780	.844
1985	1.035	1.66
1990	1.109	2.45
1995	1.252	3.85
2000	1.411	6.06

Residual Oil

	Real (1979 $)	Current
1979	.437	.437
1980	.508	.550
1985	.743	1.190
1990	.812	1.791
1995	.944	2.903
2000	1.091	4.679

Ontario Light Fuel Oil Prices ($ per gallon)
Residential, Commercial and Industrial

Case II (High Oil Price Scenario)

	Real (1979 $)	Current
1979	.703	.703
1980	.780	.844
1985	1.169	1.881
1990	1.276	2.850
1995	1.515	4.753
2000	1.822	8.028

Residual Oil

	Real (1979 $)	Current
1979	.437	.437
1980	.508	.550
1985	.867	1.395
1990	.966	2.157
1995	1.186	3.722
2000	1.470	6.475

Ontario Natural Gas Prices ($ per m.c.f.)

Case I

Residential

	Real (1979 $)	Current
1979	3.38	3.38
1980	3.78	4.09
1985	5.12	8.20
1990	5.76	12.71
1995	7.09	21.81
2000	8.02	34.41

Commercial

	Real (1979 $)	Current
1979	2.73	2.73
1980	3.13	3.39
1985	4.47	7.16
1990	5.11	11.27
1995	6.44	19.81
2000	7.37	31.62

Industrial

	Real (1979 $)	Current
1979	2.32	2.32
1980	2.72	2.94
1985	4.06	6.50
1990	4.70	10.37
1995	6.03	18.55
2000	6.96	29.87

Ontario Natural Gas Prices ($ per m.c.f.)

Case II

Residential

	Real (1979 $)	Current
1979	3.38	3.38
1980	3.76	4.07
1985	5.69	9.16
1990	6.25	13.96
1995	7.46	23.41
2000	8.98	39.57

Commercial

	Real (1979 $)	Current
1979	2.73	2.73
1980	3.11	3.37
1985	5.04	8.11
1990	5.60	12.51
1995	6.81	21.37
2000	8.33	36.71

Industrial

	Real (1979 $)	Current
1979	2.32	2.32
1980	2.70	2.92
1985	4.63	7.45
1990	5.19	11.59
1995	6.40	20.08
2000	7.92	34.90

Ontario Electricity Prices (¢ per kilowatt-hour)

Residential

	Real (1979 ¢)	Current	
		Case I	Case II
1979	2.75	2.75	2.75
1980	2.78	3.01	3.01
1985	2.92	4.68	4.70
1990	3.07	6.77	6.86
1995	3.22	9.91	10.10
2000	3.39	14.55	14.94

Commercial

	Real (1979 ¢)	Current	
		Case I	Case II
1979	2.88	2.88	2.88
1980	2.91	3.15	3.15
1985	3.06	4.66	4.93
1990	3.21	7.08	7.17
1995	3.38	10.40	10.60
2000	3.55	15.23	15.64

Industrial

	Real (1979 ¢)	Current	
		Case I	Case II
1979	2.09	2.09	2.09
1980	2.11	2.28	2.28
1985	2.22	3.55	3.57
1990	2.33	5.14	5.20
1995	2.45	7.54	7.69
2000	2.58	11.07	11.37

The following motor gasoline prices are based on Saudi Arabian oil prices reaching $40 (U.S. $ 1980) by the year 2000 (Case I) and $50 (U.S. $ 1980) by the year 2000 (Case II) in the Persian Gulf.

Canadian oil prices are moving to 85% of world prices by 1985.

All distribution margins and taxes are assumed to increase at the rate of inflation.

Motor Gasoline Prices (per gallon)

	Case I		Case II	
	Current $	1980 $	Current $	1980 $
1980	1.21	1.21	1.21	1.21
1981	1.41	1.28	1.41	1.28
1982	1.63	1.36	1.64	1.38
1983	1.88	1.45	1.91	1.47
1984	2.13	1.52	2.17	1.55
1985	2.41	1.60	2.45	1.62
1990	3.70	1.69	3.88	1.78
1995	5.69	1.81	6.25	1.99
2000	8.75	1.94	10.13	2.25

June 11, 1980
D.C. Mountain
DCM/sz

Ontario

Ministry
of
Energy

Queen's Park
Toronto, Ontario
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Telex-06217880
965- 0530

July 2, 1980

MEMORANDUM TO: David Smith
Urban and Regional Transportation Planning Office
Ministry of Transportation and Communications

FROM: Dean Mountain
Strategic Planning and Analysis Group

SUBJECT: Construction of Alternative Transportation Energy Demand Scenario

The estimates we furnished you on June 11 were not forecasts or projections. In that letter three estimates were provided.

	Consumption (10^{15} B.T.U.)
1. 1980 estimate	.570013
2. 90% of 1980 estimate	.513012
3. population growth of .8% per annum	.667651

Estimate 2 and 3 would provide a range for oil consumption by the year 2000.

Dean Mountain

Dean Mountain
Analyst

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CIGGT Project No. PRO-083 CIGGT Report No. 80-5

ONTARIO RAIL ELECTRIFICATION: A BRIEF EXAMINATION

C.E. Law (Project Leader)
G.W. English E.R. Corneil
C. Schwier R.W. Lake
R.G. Maughan J.S. Bryce
J.D. Young

Canadian Institute of Guided Ground Transport
Queen's University at Kingston, Ontario

15 July 1980

This report resulted from research conducted through the Canadian Institute of Guided Ground Transport. The report represents the views of the authors and does not necessarily have the endorsement of the University or the other participating organizations.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1 PURPOSE AND SCOPE

On 6 June 1980, the Canadian Institute of Guided Ground Transport was advised by the Minister of Transport and Communications that we had been chosen to carry out a study to provide the Ontario Task Force on Rail Policy with an analysis of a number of potential applications of electrification to certain rail corridors in Ontario. Included in the analysis were to be mechanisms for funding, and possible benefits to the economy. The study was to cover different systems of electrification, their advantages in different circumstances, and a review of electrification throughout the world, as well as schemes which have been proposed for electrification in Canada. A particular problem to be examined was the difficulty of meeting the heavy front-end capital requirements of electrification. Because of time limitations, it was not considered practical to do any substantial amount of entirely new research; rather, reliance was to be placed on updating solutions previously developed by CIGGT in studying electrification across Canada. However, it was found necessary to generate original data for several of the candidate rail lines. Even so, detailed revisions were not possible because of both time and space limitations. The study was able to draw on a partial study of GO Transit electrification, carried out by Electrack for MTC, as well as on a very thorough study of high-speed intercity passenger rail newly completed by CIGGT for Transportation Development Centre of Transport Canada, but not yet released. Within limits, therefore, the study gives reasonable guidance concerning the relative merits of electrification of Ontario's rail lines. However, the cost figures cannot be considered either highly precise or extremely accurate, and substantial tolerances must therefore be allowed.

The complete terms of reference are attached as Appendix A.

1.2 TECHNICAL CONSIDERATIONS

Railway locomotives are limited in their tractive ability by two fundamental factors: the adhesion between the driving wheels and the steel rail, and the power which the locomotive unit is able to handle effectively and deliver to the traction wheels. Together with the time frame over which this power can be delivered without overheating, other factors, such as increased weight on the driving wheels, improved slip control, etc., can increase the tractive effort to some extent. Contamination of the rail surface by rain, oil or atmospheric pollutants, and unevenness in the track alignment and, allegedly, vibration of the diesel engine tend to reduce wheel adhesion, and hence, tractive effort, or drawbar pull.

The train locomotive (a "locomotive" is one or several individual vehicle "units" electrically interconnected) must be able to pull the train over the steepest slope on the rail line, and in some cases it may be necessary to start and accelerate the train over this controlling gradient. Speeds on controlling gradients may be low, and hence the power requirements may be relatively modest. Where track and operational conditions permit, train speeds may be high, and hence both the locomotive tractive effort and its power capabilities may be important. Typically, in a diesel-electric locomotive the power capability becomes the limiting condition at higher speeds, while the tractive effort, or wheel adhesion, is the limiting factor at lower speeds. An electric locomotive has a slight adhesion advantage and a longer overload capability, and usually a higher horsepower rating. Two criteria are of special significance -- the train must not stall (i.e. be unable to start and clear the grade within an acceptable time), and there must be sufficient tractive effort and power to permit the train to traverse a given track segment within a defined time. Typically, these criteria are spelled out as an "equated tonnage rating" for a specified locomotive, and as "tons per horsepower," or its inverse, "horsepower per ton." For example, on the Toronto to Montreal line of Canadian National, the equated tonnage rating for a 3,000 horsepower, six-axle diesel unit is 2,770 tons. For an express train, they also specify 0.6 tons per horsepower, at 50 tons per car. The controlling grade on this line is 1.0 per cent, and it is a relatively high-speed track (few sharp curves and other speed restrictions).

For analysis purposes, there are a number of mathematical formulae available to estimate adhesion coefficient, train resistance, etc. The results derived from different formulae vary significantly. Table 1 illustrates key values derived from formulae used by Canadian National Railways and Canadian Pacific Railways. It is important to note that train resistance, on level track, increases significantly with increasing speed. The CN formula also indicates that the train resistance also increases with lighter cars (if train tonnage is held constant), i.e. an empty car has more resistance per ton of gross weight than the resistance per ton of a loaded car.

Table 1 indicates the tractive power required for a specific train on level track. Note that the power increases with increasing speed, but is well within the ability of a single modern diesel-electric locomotive up to 40 mph. Lifting the train up a grade at a speed of even 30 mph would add substantially to the power required (4,245 horsepower for the example train).

The sample train, operating as an express train on the CN Toronto-Montreal line, would require not less than 4,000 horsepower (0.6 tons per horsepower), and

would have a balance speed,[1] based on the CN resistance formula, of just under 50 mph on level track.

The adhesion coefficient which will be available under starting conditions when the train is forced to stop on the controlling gradient during adverse weather conditions will be the determining factor in low-speed operation. There is considerable controversy about an acceptable value for this coefficient. Some believe it to be speed-dependent. However, recent studies by the Electromotive Division of General Motors suggest that it is not speed-dependent. There is evidence to suggest that it is a function of the suspension dynamics of the locomotive trucks, and we must suspect that track dynamics also influence the value. Certainly, improved electronic slip control can increase the useful adhesion coefficient. Adhesion coefficients in excess of 0.40 have been measured, but there seems to be no agreement on an acceptable minimum value for train operation. Typically, train weights have been established by experience combined with analysis.

Electric locomotives, capable of delivering much more power per unit, and power per axle, are available. Table 1 clearly shows that the axle power is limited by adhesion at lower speeds, for both electric and diesel-electric locomotives, and suggests that the maximum unit power which can be used under adverse track conditions is 4,789 horsepower at 70 mph (for four-axle units weighing 126.5 tons). A 3,000 horsepower (tractive) locomotive cannot always use its full power until the train speed exceeds 30 mph, because of adhesive limits.

Each time a new locomotive is considered for a specific rail line, it is necessary to evaluate its performance with various train configurations, first with a computer model which simulates train performance over the line, and then with actual test runs. The replacement ratio of one locomotive unit for another depends on the locomotive characteristics, the train requirements, and the track characteristics. Most reports suggest increased train speeds for electric locomotives, to more effectively use the increased power available. However, increasing train speed decreases energy efficiency. With escalating energy costs, this may not be desirable. Increased train speeds would be possible with electric locomotives, if track conditions permit, and would make the economics of electrification more attractive. However, for purposes of this evaluation, we have assumed no change in train speed.

The locomotive traction motor would be designed to deliver a specific maximum torque and would have a maximum rated speed (rpm). Heat dissipation from the motor would limit short-term and long-term power capacities. Typically, a traction motor can deliver its maximum torque for a period of only five to six

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1 At balance speed, power required balances power available.

TABLE 1

LEVEL TRACK TRAIN PERFORMANCE, WITH TWO FOUR-AXLE LOCOMOTIVES, EACH WEIGHING 126.5 TONS

	Train Speed (mph)							
	0	10	20	30	40	50	60	70
Train Resistance (lbs f)								
48 cars of 50 tons:								
CN	5,592	6,965	10,306	15,615	22,893	32,138	43,351	56,533
CP	5,439	6,365	7,551	8,998	10,704	12,671	14,899	17,386
36 cars of 75 tons:								
CN	4,312	5,372	7,773	11,517	16,601	23,028	30,796	39,906
CP	5,439	6,365	7,551	8,998	10,704	12,671	14,899	17,386
24 cars of 100 tons:								
CN	3,672	4,575	6,507	9,407	13,456	18,473	24,518	31,592
CP	5,439	6,365	7,551	8,998	10,704	12,671	14,899	17,386
Train Power (hp)								
48 cars of 50 tons:								
CN	0	186	550	1,249	2,442	4,285	6,936	10,553
CP	0	170	403	720	1,142	1,690	2,384	3,245
36 cars of 75 tons:								
CN	0	143	415	921	1,770	3,070	4,927	7,449
CP	0	170	403	720	1,142	1,690	2,384	3,245
24 cars of 100 tons:								
CN	0	122	347	757	1,435	2,463	3,923	5,897
CP	0	170	403	720	1,142	1,690	2,384	3,245
Adhesion Coefficient	0.2393	0.1922	0.1639	0.1455	0.1310	0.1178	0.1066	0.1014
Maximum Tractive Effort (lbs f)	121,086	97,246	82,958	73,620	66,273	59,607	53,959	56,311
Maximum Track Power/Unit (hp)	0	1,247	2,380	2,945	3,535	3,974	4,317	4,789

minutes. After such an overload condition, it is necessary to permit the motor to cool down by operating substantially below the continuous rating for an equal period immediately after the overload. Typically, in railway operation, undulations in the terrain permit the use of overload ratings for starting and hill climbing, if train speeds are sufficiently high and the climbing grades are not too long.

We have selected, for comparison purposes, two modern four-axle locomotives. Table 2 provides the pertinent specifications. Note that the gear ratio selected influences the maximum tractive effort that can be delivered. The gear ratio, selected to provide a locomotive with a desired maximum speed, will affect the maximum torque, and hence tractive effort, at the driving wheels. Thus, for a specific traction motor, a locomotive with a top speed of 84 mph can deliver a maximum tractive effort of 65,000 lbs, whereas a top speed of 100 mph reduces the maximum tractive effort to 55,650 lbs. For passenger and express services, we selected the 100 mph electric locomotive, but for freight service we selected the 84 mph electric unit.

1.2.1 Passenger Trains

Passenger trains are usually operated at relatively high speeds, and require good acceleration characteristics. Typically, they are power-limited, with adhesion becoming an important characteristic only during starting. Analysis reveals that a single electric locomotive, rated at 5,100 horsepower (tractive) can provide performance equal to two diesel-electric units of 3,000 horsepower each. Table 3 and Figures 1 and 2 illustrate the pertinent characteristics of balance speed and acceleration. Note that, although slower during the initial acceleration stage, at higher speeds the electric locomotive acceleration exceeds that of the diesel-electric unit, providing comparable overall performance. Although Table 3 evaluates a light electric locomotive (European style), the adhesion required during starting exceeds values presently accepted in North America. The heavier electric locomotive uses values of adhesion comparable to the diesel-electric unit, and still provides acceptable acceleration rates. The reduction in train weight and train resistance resulting from the replacement of two diesel-electric locomotives with only one electric locomotive offsets the train power reduction of 900 rail horsepower.

Thus, for passenger trains, the replacement ratio is one electric unit for two diesel-electric units. If passenger trains are not operated in blocks of ten coaches, then the ratio must be adjusted to meet the train demands. VIA schedules were used to establish the train speeds and equipment requirements for two sample sites.

TABLE 2

LOCOMOTIVE SPECIFICATIONS

	GP40-2	RC4(1)	RC4(2)	RC4(3)
Gear Ratio	2.01711	106/37	87/26	106/37
Power Rating (hp)	3,000	5,100	4,850	5,100
Locomotive Weight (tons)	126.5	86.0	126.5	126.5
Maximum Speed (mph)	95	100	84	100
Maximum Tractive Effort(lbs)	57,360	55,650	65,000	55,650
Continuous Rating (lbs)	38,240	37,000	42,500	37,000

TABLE 3

PASSENGER TRAIN PERFORMANCE

	GP40-2	RC4 (86 tons)	RC4 (126.5 tons)
Trailing Tonnage	375	750	750
Balance Speed (mph):			
level track	89	87	86
1 per cent grade	65	64	63
Acceleration (from 0 mph):			
Distance:			
level track:			
30 mph	1,152 ft	1,161 ft	1,268 ft
60 mph	7,621 ft	6,825 ft	7,460 ft
one per cent grade:			
30 mph	1,587 ft	1,699 ft	1,899 ft
60 mph	19,196 ft	17,517 ft	21,631 ft
Time:			
level track:			
30 mph	0.84 min	0.84 min	0.92 min
60 mph	2.35 min	2.17 min	2.37 min
one per cent grade:			
30 mph	1.15 min	1.23 min	1.37 min
60 mph	5.03 min	4.70 min	5.66 min

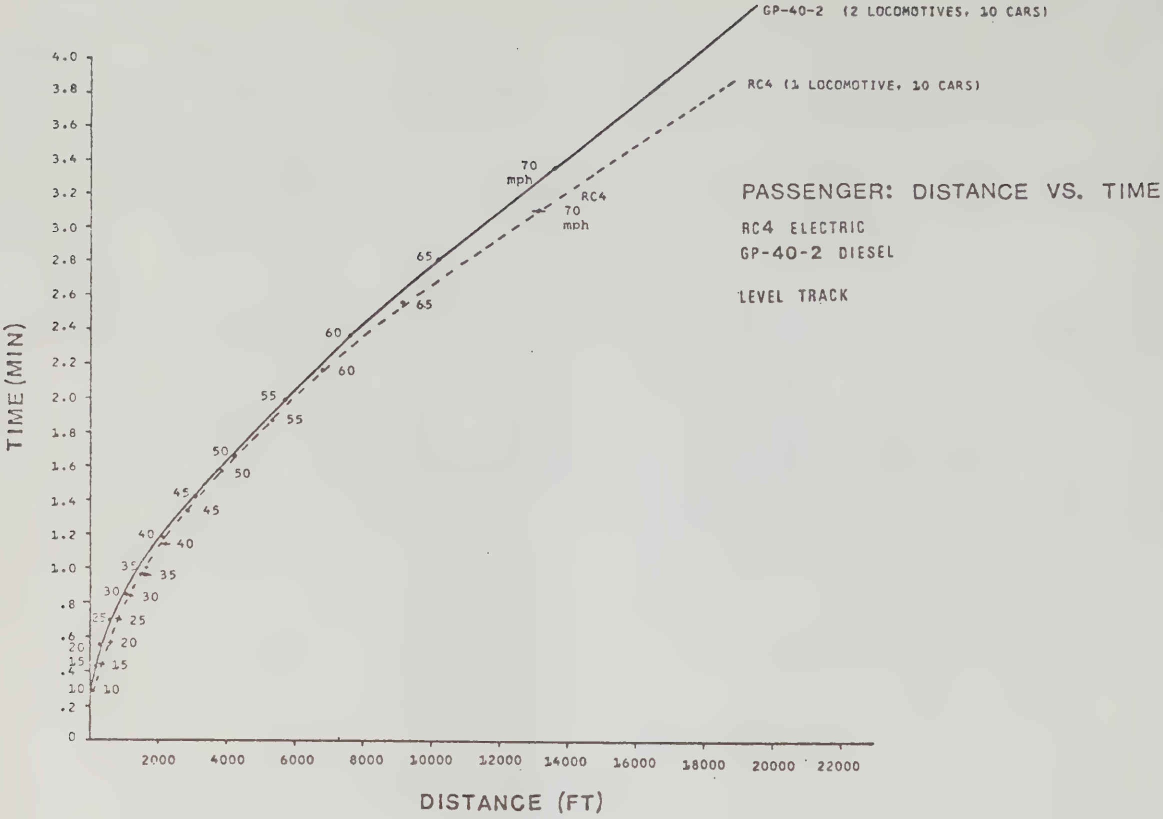

Figure 1   Passenger locomotive acceleration (level track)

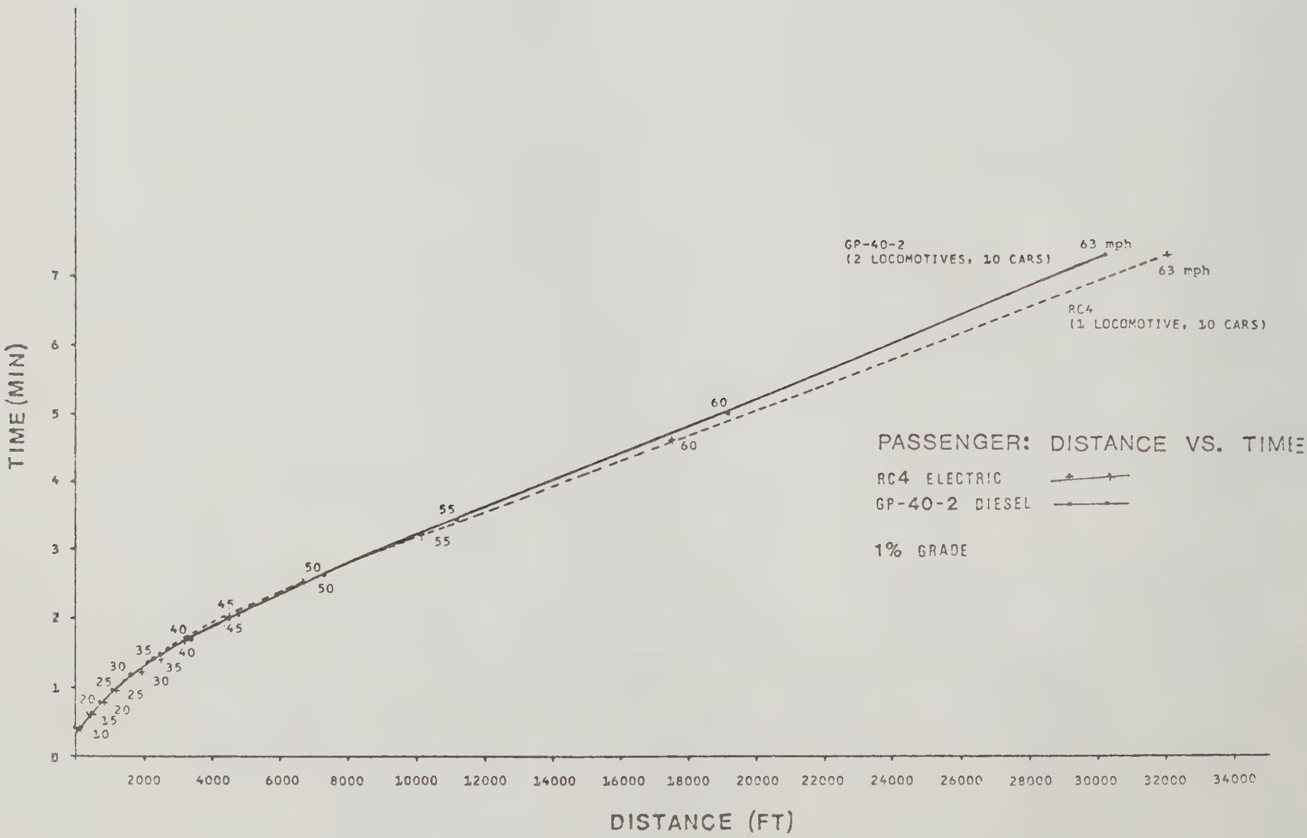

Figure 2   Passenger locomotive acceleration (1 per cent grade)

1.2.2 Express Trains

Diesel-electric-powered express trains are power-limited except during the initial acceleration period while starting the train. However, the higher power electric locomotive is traction-limited for a good portion of the train operation.

Analysis of the balance speeds and acceleration characteristics of diesel-powered and electric-powered express trains reveals that overload operation during starts on the controlling grade is essential. The duration of the overload period and the length of the controlling grade are critical factors in establishing the tonnage capacity of each locomotive.

Using a 1.0 per cent grade 2.5 miles in length as the controlling grade, the diesel-electric unit could haul 1,240 trailing tons. Table 4 and Figure 3 illustrate balance speeds and accelerations for this configuration. It is necessary for the diesel-electric locomotive to operate in overload during a start on the controlling gradient.

With the electric locomotive unit, using full overload capacity, 1,360 trailing tons can be started on the controlling grade. However, with reduced overload demand, and a longer acceleration period, the electric locomotive unit can start a train of not less than 1,440 trailing tons on the controlling grade. This is also illustrated in Table 4 and Figure 3. The electrically-powered train would require slightly longer to achieve 30 mph, but the superior acceleration at higher speeds permits reduced train times to 50 mph. The electrically-powered train would thus provide reduced station-to-station times on a typical track segment.

Analysis indicates that the electric locomotive unit could haul 1,840 trailing tons and still provide overall performance comparable to that of the diesel-electric. Starting over the controlling gradient would still be possible (with acceptable adhesion values) by limiting the maximum tractive effort to 50,000 lbs during the start. Starting performance would be comparable to the diesel-electric locomotive, except on the controlling grade.

For analysis purposes, the unit replacement ratio for express trains was on the basis of 1,240 trailing tons for diesel-electric units, and 1,840 trailing tons for electric units. Again, express schedules were used to establish train speeds and frequency, and adjustments to the ratio were required to match the scheduled train frequency. Thus, the actual replacement ratio was less than 1,840/1,240:1.

TABLE 4

EXPRESS TRAIN PERFORMANCE

	GP40-2	RC4 (126.5 tons)					
Overload Factor		1.50	1.40	1.30	1.20	1.10	1.00
Trailing Tons	1,240	1,360	1,440	1,440	1,440	1,440	1,440
Balance Speed (mph)							
level track	65	77	75	75	75	75	75
one per cent grade	34	47	45	45	45	40	26
Acceleration:							
Distance (ft):							
level track: 30 mph	2,231	2,088	2,381	2,584			
50 mph	11,863	7,199	7,985	8,242			
1 per cent grade: 30 mph	7,439	4,984	7,131	9,344			
Time (min.)							
level track: 30 mph	1.501	1.511	1.720	1.865			
50 mph	4.064	2.887	3.211	3,399			
1 per cent grade: 30 mph	4.190	3.546	5.009	6.480			
Trailing Tons			1,760	1,840 (overload) (1.35)			
Balance speed (mph)							
level track			70	69			
one per cent grade			39	38			
Acceleration:							
Distance							
level track: 30 mph			1,888	3,145			
50 mph 50 mph			9,920	10,668			
1 per cent grade: 30 mph			16,222	32,421			
Time (min.)							
level track: 30 mph			2.080	2.261			
50 mph			3.972	4.287			
one per cent grade: 30 mph			10.820	19.964			

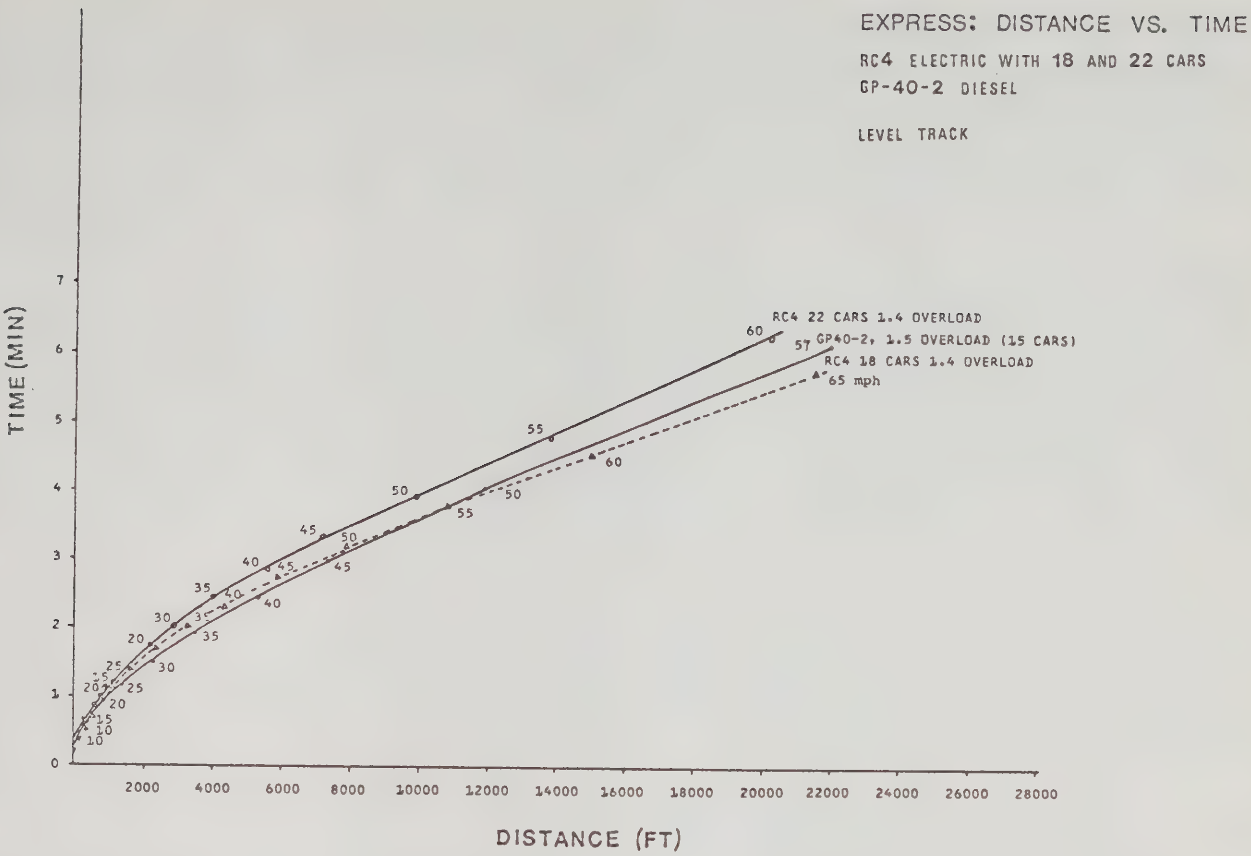

Figure 3(a) Freight locomotive acceleration - express service (level track)

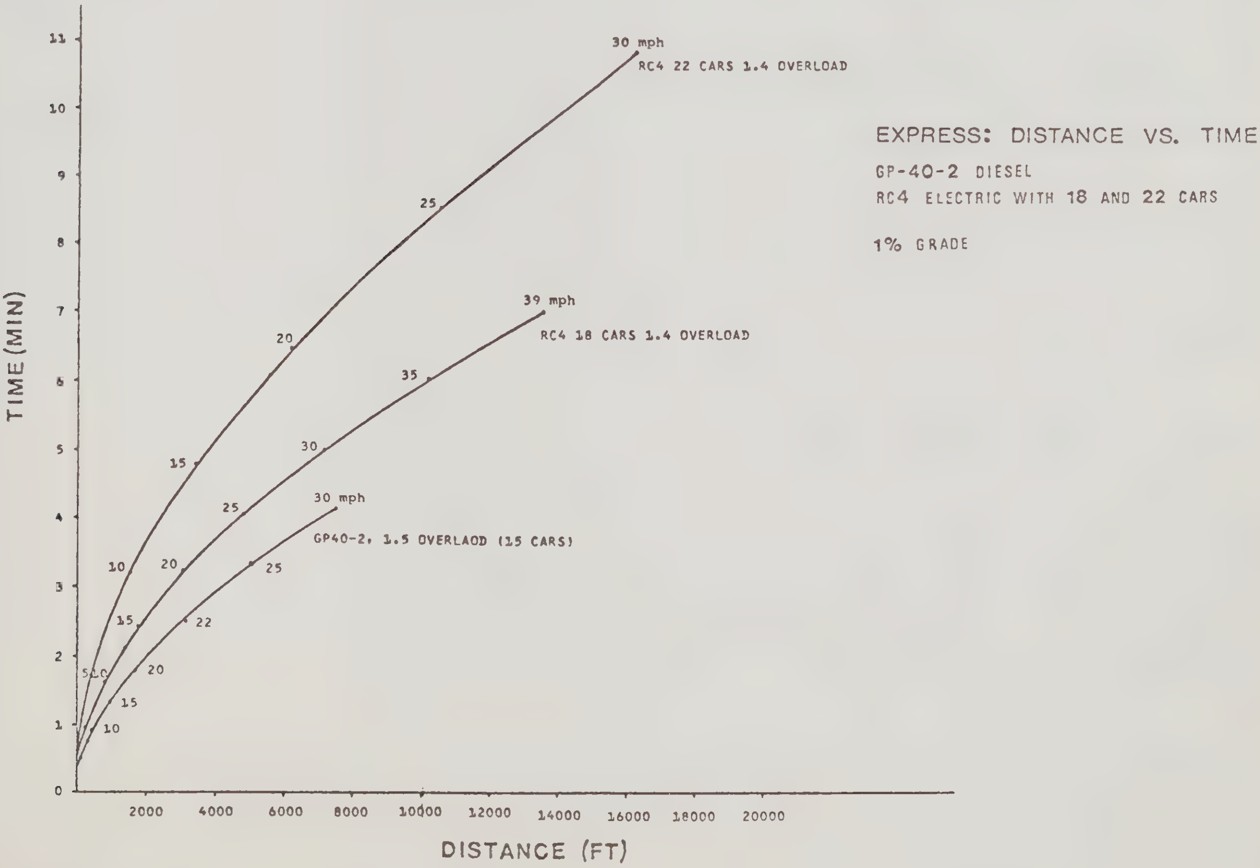

Figure 3(b) Freight locomotive acceleration (1 per cent grade)

Express and passenger schedules mesh in a way which permits some interchange of passenger and express locomotives. This was considered, where possible. Thus, the 100 mph electric locomotive was selected for passenger and express services.

1.2.3 Freight Trains

Freight trains are traction-limited during a considerable portion of their service, and the equated tonnage rating is essentially a function of the ability to start on the controlling gradient. With current diesel-electric locomotives, the horsepower per ton ratio is close to 1. With higher powered four-axle units, such as the GP40-2, the trailing tonnage is limited by the tractive ability. Hence, the horsepower per ton would be greater than 1, with a consequent reduction in trip time possible.

For freight operation, the replacement ratio was established on the basis of rated tractive effort at start, under maximum overload conditions. The 84 mph electric unit was selected, since it provided a higher tractive rating. The ratio used was 65,000/57,360:1.

1.2.4 Motive Power Requirements

Rail traffic is not evenly distributed over the day or the year, and any analysis must reflect this. In the extreme case, identified by a detailed study of this variability carried out as part of the 1976 analysis, it would be necessary to have twice as much equipment for freight and express operations as the annual traffic figure would suggest. In addition, maintenance requirements limit the availability of motive power. Equipment availability was estimated at 85 per cent for diesel units and 95 per cent for electric units. Use of the higher power electric locomotives results in a reduction in traffic tonnage over the track (fewer locomotive trips), and hence a saving in both energy and track maintenance costs.

1.2.5 Power Supply System

The "Electrification of GO Transit Rail Services" consulting report by "Electrack" (May 1980) provides up-to-date design criteria and cost figures. The design proved comparable to that used in the CN electrification study of 1971 and in the more recent "Canadian Railway Electrification Study: Phase I," CIGGT Report No. 76-1.

The GO system proposal (Phase I) involves a single substation end, feeding some 21 to 22 miles of catenary. Based on double track (and hence, cross-feeding between the two catenary lines), "Electrack" indicated satisfactory performance for up to six locomotives drawing 4.2 MVA and four locomotives drawing 0.6 MVA

from the line. These locomotives would be distributed along the two catenary lines. Our analysis indicates that a single express freight train at the end of the line (Pickering) could only draw 8.0 MVA (no other traffic) before the catenary voltage drop became excessive. An express train of three units (each could draw up to 5.1 MVA) could operate at reduced speed (approximately 30 mph) under these conditions.

The catenary wire system is heavy enough to handle such an express train at full power. However, closer substation spacing would be required to permit full power operation of the electric locomotives (for the units selected, this would not occur at train speeds of less than 35 mph). Addition of a substation at Pickering would permit passenger and express traffic to move to the Union Station area of Toronto without serious operating limitations.

For the Toronto-Montreal route and for the freight routes in general, the number of overhead bridges and other overhead restrictions requires that a detailed analysis of these restrictions, and the cost of modification relative to 25 or 50 kV catenary, be carried out. The additional substations required for 25 kV, and the cost of feed lines, would add some 45 million dollars to the electrification cost for Toronto-Montreal. If necessary, locomotives (dual voltage) could move from 25 kV to 50 kV lines without difficulty (little more than a phase break).

The analysis includes costing of substations (50 kV) and the necessary high voltage feed lines. Acquisition of right-of-way for the feed lines would substantially increase the cost of feed lines for the Toronto-Montreal route, and this has been included.

1.2.6 Signalling and Communications Systems

A number of changes to the railway signalling and communications systems would be necessary in conjunction with high-voltage a.c. electrification. Although the current spectrum of world train control technology is quite broad, ranging from unsignalled freight operations on many branch lines to computer-aided dispatching and automatic train control on the Japanese Shinkansen, the signalling on the candidate routes for electrification is largely based on the signal "block" -- a length of track to which entrance is governed by wayside or in-cab signal indicators. In an automatic block signalling system (ABS), these block signals are activated automatically by the presence of a train or the position of interlocked mainline switches. In conjunction with Centralized Traffic Control (CTC), this type of signalling provides an effective means of collision protection and train movement authorization.

On non-electrified railways, the actual signals for the ABS system are typically transmitted through direct current (d.c.) track circuits. An open-wire system parallel to the rail line carries the signal, with power to operate the signal inductors supplied either from wayside or over the open-wire system. The track circuit is used to indicate the presence of a train within a signal block, and permits the CTC operator to continuously monitor the progress of each train within his territory. Track circuits are also used to trigger road/rail crossing signals, and as a means of detecting breaks in both rails.

Since the return current of an a.c. electric propulsion system travels to the rails, and thence to the ground return system, the rails carry a heavy a.c. current. This presents two problems. The track circuits must be made immune to the a.c. voltage produced in the rail, and the insulating joints which divide track blocks must be modified to conduct the traction current.

A number of solutions to the first problem exist, including the use of an a.c.-immune relay developed by the British, but the use of relatively low frequency (100 Hz) pulse-coded or phase-coded a.c. track circuits is favoured for North American applications. These circuits, which have been specifically designed for use with modern a.c. propulsion, provide continuous train detection, broken rail protection, and protection against defective insulated joints. Individual circuit lengths of 4,000 to 6,000 feet can be used, depending on ballast conditions. The second problem is overcome by installing impedance bonds at insulated rail joints to prevent the relatively weak track circuit signals from passing to adjacent blocks.

It is also necessary to shield the signal wires from the effects of electromagnetic induction. Typically, the signal wires are cabled, and the cable is wrapped with permeable steel tape, with the shield grounded. Placing the signal cable underground virtually eliminates the problem of electrostatic induction. However, the underground cable does require a high-conductivity shield to minimize the effects of ground potential conduction. The use of fibre optics in place of conventional signal wires could eliminate these problems with induction effects.

Electromagnetic and electostatic induction between wires running parallel to the rail line and the catenary will require modification to the adjacent communication lines. The open-wire pole line, characteristic of many rail rights-of-way, will no longer be suitable. The use of buried cable, or some alternate means such as VHF radio and microwave, will be necessary.

Open-wire systems of other common carriers, which run parallel and close to the rail right-of-way, may prove to be a problem. However, indications are that lines crossing the right-of-way, or cabled systems, should not be seriously affected.

1.2.7 Dual-Mode Locomotives

The dual-mode locomotive (DML) has a conventional diesel engine-alternator set as well as a pantograph and transformer to receive electricity from the catenary to power the traction motors. The idea of the DML is not revolutionary. DML's have operated successfully in large passenger terminals where the presence of diesel fumes are undesirable. Also the U.S. DOT has studied using dual-mode locomotives on electrified sections of steep gradients (the DML operates with an output of 50 per cent more power from catenary than from the diesel engine).

The DML can be ordered as a feature on new locomotives, as well as retrofitted to existing motive power. The SD-40-2 is best suited for this conversion due to the space avilability in the car body (both CP and CN currently operate SD-40-2 locomotives). The DML could prove useful where trains would have to venture away from electrified territory to serve branch lines and industrial spurs.

1.3 ELECTRIFICATION ON WORLD RAILWAYS

1.3.1 Some History

Electrified railway operation has a long history, commencing with experimentation in Germany and Switzerland in the 1870's and 1880's. However, the world's first main line operation was in the United States, where in 1895 the Baltimore and Ohio Railway electrified a 5.5 km tunnel operation. Other early installations included a short line near Berlin, Germany (1901) on which a speed of 135 mph was achieved two years later, and the tunnel portion of a line connecting Switzerland and Italy, built in 1906.

Canada too has a share in the history. In order to overcome the problems of ventilation arising from operation of steam locomotives, the 2.8 km St.Clair River tunnel at Sarnia, built in 1889-90, was electrified in 1906, along with approaches of about 1.5 km on each side. It was not converted to diesel operation until the late 1950's. The original Canadian Northern line built in 1915 through and running north from the 5 km, double-track Mount Royal tunnel in Montreal was and is still electrified, although a portion of it was converted with the advent of diesel operation.

Electrified "inter-urban" railways played a very important part in Canadian transportation in the early years of the twentieth century, reaching a surprising total of 1,737 miles (2,800 km) by 1925. The Niagara, St.Catherines and Toronto Railway (NStCTR) was one of the busiest and earliest of these, opening its first line from St.Catherines to Thorold in 1887. In the 1920's the Ontario Hydro Electric Power Commission itself operated systems in and around Toronto (later disposed of to the Toronto Transportation Commission), Windsor,

Guelph and Peterborough. A small system was operated in Cornwall by the Cornwall Street Railway Light and Power Co. There was even a small line connecting Colbalt and Haileybury. Other lines existed in the Maritime Provinces, Quebec and British Columbia, the latter being operated by the British Columbia Electric Co. and having at one time a mileage of 375 miles (604 km), including an extensive system in the Lower Fraser Valley around Vancouver. The growing popularity of the private automobile contributed quickly to the demise of most of the inter-urban lines, although a few survived in a limited way until the 1950's and the Cornwall line until 1971.

1.3.2 Current Status

Current statistics reveal that there are close to 155,000 route-kilometres of electrified railway in operation throughout the world (see Table 5). In addition there are more than 5,000 route-kilometres of transit line, bringing the world total of electrified rail operation to 160,000 route-kilometres. This represents almost 13 per cent of the world total of 1,247,000 railway route-kilometres.

In fact, current world total electrified railway route length is somewhat greater. The latest data reported are, as may be seen from Table 5, no more recent than the end of 1978. In some instances they date back ten or more years and some additional unreported conversion to electrified operation has since occurred.

Statistics are not available as to what percentage of the total world railway freight tonne-kilometre carried is represented by the tonne-kilometres carried on electrified routes. However, on individual railways the proportion of tonne-kilometres carried on electrified lines is characteristically much higher than the simple percentage of the total railway length represented by the electrified portion. For example, in 1974, when only about 25 per cent of the route length of the USSR system was electrified, those lines were carrying 51 per cent of the total traffic.[2] Currently, in Austria 90 per cent of the traffic is being carried on the 49 per cent of the Austrian system that is electrified.[3]

There are a number of reasons for this, the most important of which are that:

- comparatively high annual tonnages are needed for economic justification of conversion to electrified operation and hence the heaviest traffic lines are generally the first on a system to be converted

2 Personal communication, Soviet transportation officials to one of authors.

3 Jane's World Railways, 1978-80

TABLE 5

ELECTRIFICATION - WORLD RAILWAYS*

Country		Route-Kilometres Electrified		Percentage of Principal System Electrified
		Principal Railway System	Minor† Railway Systems	
Europe:				
Austria	(1976)	2,850	28	49
Belgium	(1978)	1,507	-	35
Bulgaria	(1975)	1,326	-	33
Czechoslovakia	(1964)	3,120	-	24
Denmark	(1978)	101	-	5
Finland	(1978)	675	-	11
France	(1978)	9,710	193	28
East Germany	(1975)	1,123	331	8
West Germany	(1978)	10,657	385	37
Hungary	(1977)	1,211	-	16
Italy	(1978)	8,382	1,203	52
Jugoslavia	(1976)	2,649	-	26
Luxembourg	(1978)	137	-	50
Netherlands	(1978)	1,731	-	60
Norway	(1975)	2,440	16	57
Poland	(1977)	5,988	-	25
Portugal	(1978)	432	-	15
Roumania	(1977)	1,702	-	15
Spain	(1976)	4,393	168	33
Sweden	(1978)	7,062	410	63
Switzerland	(1978)	2,844	2,134	99
USSR	(1978)	41,122	-	†
		111,162	4,868	
Great Britain	(1978)	3,766	60	21
Middle and Far East:				
China	(1978)	2,087	-	4
India	(1978)	4,475	-	7
Indonesia	(1974)	77	-	1
Japan	(1978)	9,209	2,001	43
Korea North	(1979)	264	-	6
Korea South	(1977)	428	-	7
Pakistan	(1978)	290	-	3
Taiwan	(1977)	555	-	55
Turkey	(1978)	202	-	†
		17,587	2,001	
North America:				
Canada	(1979)	43	-	-
United States	(1978)	2,353	-	-
		2,396		
South America:				
Argentina	(1978)	127	-	-
Bolivia		-	13	-
Brazil - RFFSA	(1978)	1,047	62	4
Brazil - FEPSA	(1978)	1,742	-	30
Chile	(1977)	893	57	11
		3,809	132	
Cuba		145	-	-
Costa Rica		156	-	26
Africa:				
Algeria	(1978)	256	-	10
Egypt	(1979)	50	-	1
Morocco	(1978)	708	-	4
South Africa	(1978)	5,567	-	24
Zaire	(1978)	858	-	17
		7,439		
Australia, NSWPTC	(1979)	456	-	5
Australia, VR	(1978)	477	-	6
New Zealand		99	-	2
		1,002		
Total		147,462	7,061	
Grand Total		154,523		

* Excerpted from Railway Directory and Year Book - 1980. IPC Transport Press Limited, Dorset House, Stamford Street, London.

† not including Transit

- in itself, electrified operation enables higher levels of traffic than does steam or diesel-electric operation.

1.3.3 Future Conversion

The continued escalation of world oil prices combined with developments in electrification technology (such as the thyristor equipped locomotive) have, in recent years, maintained interest in electrification at a high level within many railway administrations throughout the world. Many of those with no electrified operation at present are studying the pros and cons of starting the process. The majority of those administrations which already have some portion of their system converted are in the process of adding more electrified route-kilomtres. The more significant of such programs, as reported by Jane's World Railways and other literature, are synopsized in the following.

France

France is engaged in a continuing expansion of its electrified rail network on the basis of a ten-year planned program to cost Frs 400 million annually at 1977 prices. By the 1990's SNCF hopes to bring their total electrified routes to 13,400 km, with electric traction handling 85 per cent of mainline passengers, 88 per cent of freight, and all Paris suburban travel. One of the higher profile projects currently in progress is the new 388 km high-speed line between Paris and Lyon. This new electric line will go into service progressively, and, it is expected, will be fully in service by the mid-1980's. Speeds initially are planned to be 260 km/h, moving later to 300 km/h.

West Germany

Expansion of the electrified network will continue. Planning is for passenger train speeds of 200 to 300 km/h and new, lightweight, electric multiple-unit trainsets are being acquired for that service.

Italy

A five-year program of conversion and modification of approximately 600 route-kilometres is nearing completion.

Finland

Conversion is currently taking place on the basis of a program which is planned to bring the total electrified route-kilomtres to approximately 1,800, or about 30 per cent of the total system, by the year 1985.

Bulgaria

Continued electrification of the system is in progress. The plan had been to have approximately 50 per cent of the total network electrified by 1980. Although the schedule has fallen behind, work is continuing.

Jugoslavia

Included in the railway planning is provision for extension of electric traction by another 1,200 km of key sections, so that by 1985 a total of 3,500 km, or approximately 35 per cent of the system, will have been electrified.

Spain

Conversion of an additional 1,100 route-kilometres is planned, which will bring the total electrified route length to approximately 5,500 km, or more than 40 per cent of the system total.

USSR

Each of the Soviet Railway System's five-year plans provides for additional conversions to electrified operation. No figures are available as to distance to be converted under that system's current five-year plan, but the plan does call for the acquisition of 2,200 new electric locomotives. The Russian dedication to electrification is significant in that important operating parameters there, such as gauge, locomotive horsepower, train weight and climate more closely approach those of Canada than do those of any other country having a substantial electric operation.

Japan

Expansion of the high-speed electric traction Shinkansen network is continuing and passenger traffic is growing correspondingly. The system moves three-quarters of a million passengers a day at speeds up to 260 km/h.

Great Britain

British Rail is moving faster into electrification. One of the better known manifestations of this is the electric Advanced Passenger Train (APT) designed for speeds to 250 km/h. Some 3,000 additional kilometres of the British Rail System are considered to be potential candidates for electrification.

South Africa

On top of the 5,567 route-kilometres converted to electrified operation at the end of 1978, the South African system has under construction and/or planned an additional 1,240 route-kilometres.

United States

Although in the 1930's the U.S. had more electrified mileage than any other country in the world, the advent of the diesel-electric locomotive and a plentiful supply of domestic petroleum has led to displacement of most of the electric operations. However, the recent criticality of oil supply and its cost have led to serious studies of conversion to electrified operation by many of the major roads such as the Burlington Northern, Southern Pacific, Southern and Sante Fe. The Federal Railroad Administration (FRA) has funded other studies of a more general nature.

Two new electrified coal hauling railroads have in fact been constructed recently. A 15-mile, 25 kW, 60 Hz line, the Muskingum Electric Railroad, was completed in 1971. The Black Mesa and Lake Powell Railway in Arizona was built in 1972-73 to haul coal from the mine to the coal-fired generating station some 78 miles distant. The catenary operates at 50 kV, 60 Hz, and powers trains of up to 13,000 gross tons at 60 mph.

Two additional lines, one of ten miles and one of 13 miles, were constructed in the 1970's for the Texas Utilities Generating Co., a subsidiary of Texas Utilities. Both lines operate at 25 kV.

The major improvements being carried out to the AMTRAK-owned and operated Northeast Corridor (NEC) include, besides upgrading of track, signals and structures, a substantial electrification component. New electrification will be installed where none exists from Boston to New Haven, and the existing electrical system between New York and Washington will be modernized. The program is funded by the U.S. Department of Transportation, Federal Railroad Administration, in cooperation with AMTRAK. When completed, electric-powered trains will operate at speeds up to 200 km/h.

1.4 EARLIER CANADIAN ELECTRIFICATION STUDIES

Electrification was first considered in Canada by Canadian Pacific as early as 1895. Other CP studies followed in 1911, 1915 and 1924, and more recent studies have been carried out by both major railways over the past fifteen years.

CN Rail, who have had an electric suburban operation in Montreal since 1915, examined electrification of their Montreal/Toronto route in 1965 and the work was updated in 1969. They also studied the busy Edmonton/Vancouver line in 1973 but as with the Toronto/Montreal corridor, found the return on investment to be insufficiently attractive at the time. Traffic increases and much higher fuel prices have led to a current re-examination of the Edmonton/Vancouver route.

During the period 1970-74, CP examined the benefits that conversion would provide in overcoming operating problems being experienced in handling steadily increasing traffic levels on their single track line between Calgary and Vancouver. Recently, the addition of sections of a second track has been undertaken both to reduce gradient and to forestall the adverse impact of continuing growing traffic on operations. During the same period, studies were made of their Winnipeg/Thunder Bay line and a cursory examination was made of the Montreal/Toronto line. It was concluded in both instances that conversion was not justified by traffic levels at the time.

In 1974 a study was made for the Cartier Railway Company by Canadian Pacific Consulting Services Inc. It is understood that both the Cartier and the QNSL railways are still considering options of partial electrification.

A comprehensive evaluation of electrification of the entire CN and CP Canadian rail network was carried out by the Canadian Institute of Guided Ground Transport in the 1976 "Canadian Railway Electrification Study: Phase I." The study was undertaken at the request of the Railway Advisory Committee (a joint committee of the Railway Association of Canada and the Transportation Development Agency of Transport Canada) under contract with the Transportation Development Agency. In compliance with the terms of reference, the study attempted to define <u>when</u> rail electrification should occur. This was accomplished through an examination of the many factors which influence that timing, such as the future supply and cost of diesel fuel, the substantial financial investment required, with its long payback period, and the necessary technical development to adapt to Canadian operating conditions. The report reveals that for most of the system there was at that point adequate preparatory time before increased traffic levels and escalating oil prices combine to justify conversion. However, the traffic projected for several of the western rail lines will economically justify electrification before such work can be completed.

1.5 SOME GENERAL PROBLEMS OF TRANSITION

Extensive and technically successful electrical railway operations are occurring daily throughout many countries of the world. The pace of conversion of additional route kilometres to electric traction suggests, although it does not in itself prove, that conversion is also economically successful. Even if that is

so, it cannot be assumed that it would also be the case in Canada were our system to be converted. Likewise, technically successful electrified operation in other parts of the world does not guarantee equal technical success in Canada. Our trains are longer and many times heavier, distances greater, and our operating philosophies constrained by economic and other factors applicable to Canadian conditions. Although each of the three areas basic to the success of Canadian electrified rail operations -- technical, financial and operational -- have been explored through study, there is no Canadian operating evidence that one or all will not inhibit successful fulfillment of electrification. The CIGGT Canadian Railway Electrification Study of 1976 has in fact identified various uncertainties within each area that remain to be resolved.

1.5.1 Economic and Financial Evaluations

Undoubtedly the greatest uncertainty relates to the financing and economics of electrification. In the long term, it seems apparent that electrification can be not only economically viable but economically attractive. For this to be the case, however, high traffic volumes are needed and although these are expected to occur on much of the Canadian system, they remain, at this time, only forecasts. An additional disincentive to conversion of Canadian rail operations is the large capital investment that must be made with a much-delayed return on that investment.

In that respect, and as is evident, a railway cannot inch its way into electrification. Entire routes must be converted to the new form of traction before electric operation can commence. In the meantime, construction of the necessary catenary and substations will constitute a major impediment to smooth traffic flow, and money and manpower required for these, as well as for new locomotives, and for facilities to maintain those locomotives, will be unavailable for projects which have a more immediate payoff. The short-term adverse impact on corporate profitability is thus twofold, and the lack of enthusiasm for such a venture can be readily understood. The road to insolvency is littered with corporations which have jeopardized the present -- albeit a lean present -- in pursuance of a more profitable future.

Before a commitment to electrification can be made, it is essential that thorough economic and financial evaluations of the costs and benefits, both corporate and national, be undertaken and completed. Such work must include, inter alia:

- Comprehensive Sensitivity Analysis. To evaluate the impact of variations in traffic levels, costs, interest rates and other potential variables.

- Financial Analysis. Various scenarios should be examined with a view to postulating cash flows during and after conversion. Methods of financing must be examined.

- Economic Analysis. Benefits will accrue to both the railways and the nation. A detailed economic analysis, identifying both corporate and national costs and benefits would assist in identifying the nature and extent of governmental participation which should occur.

It is unlikely that Canadian railway electrification could take place without governmental participation. Investment levels would be high, and payback slow, even given realization of the forecast higher traffic levels. It does not appear that current profitability of the Canadian rail industry, or its profitability during the early and medium terms of a conversion program, could in itself sustain the necessary investment program. That should not be construed to mean that banks and other financial agencies would not play a substantial role in debt financing, but rather that special government guarantees and concessions will also be needed.

National benefits are significant, not only in the form of reduced oil imports but also through the strengthening of Canadian industry through supply of the large quantities of hardware and equipment needed for conversion, including locomotives. This suggests that a significant level of governmental participation would be justified. The acceptability of such participation, particularly by the privately owned segment of the industry, might be a factor of importance.

1.5.2 Technical and Operational Studies

In contrast to practice in European railway operations and those of most other countries, a major characteristic of Canadian rail operation is the long heavy freight train. Trains in excess of 10,000 gross tons are commonly operated here, compared with the 2,000 ton range that is normal in Europe. Various factors basic to the economics of rail operation are responsible for the evolution of the Canadian pattern of operations, and the design and operation of an electrified system must accommodate that pattern to the greatest extent possible. The simple transfer of European technology will not be sufficient for Canadian requirements, although the extensive experience there will be of very great assistance throughout the design and implementation of a Canadian electrification project. Recent North American construction has been too limited to provide an adequate base. Although neither technical nor operational feasibility are in question, extensive work in both of these areas is still required. Some of it, because the findings will influence economic viability, must be accomplished before a rational decision to electrify can be taken. The following is a summary of the more significant necessary work.

1.5.2.1 Locomotive Design

A number of the features of the locomotive will have significant impact on other system elements. The train power rating defines the catenary current rating, the substation rating, and the electric supply parameters. Locomotive unit size affects train size and hence train frequency, train length, etc. Locomotive elements affect maintenance requirements, and hence maintenance facility design. Electrical interference affects signal and communications systems. It is important that those features affecting other aspects of the system be defined as early as possible.

The determination of optimum axle power should be made prior to the decision to electify, since other projects upon which costs are dependent require this information. So also should determination of the control philosophy for the electric locomotive (the rate at which power is applied to reach track speed), since the philosophy adopted may have a significant effect on the power demands, and hence on design and cost of the electrical transmission system.

Other locomotive design considerations that are of significance and must receive early attention include:

- overload capacity
- number of axles
- traction motor torque and gear ratio
- axle-hung or frame-hung traction motors
- rectifier bridge design
- locomotive maintainability
- configuration of cab interior.

1.5.2.2 Train Evaluation

The train size will depend on a number of factors, some locomotive-related, some terrain-related, and some performance-related. Detailed equipment requirements will eventually require a detailed analysis of train performance for each specific region. Analytical tools for this purpose will be needed in addition to present train simulation programs and their development and use will constitute an important part of system design.

1.5.2.3 Catenary Design

A general specification for the catenary will be needed, along with design techniques.

1.5.2.4 Wire Size

The locomotive power defines the current demand from the catenary and the locomotive voltage tolerance defines the maximum permissible voltage drop in the catenary system. An evaluation of current capacity for various wire configurations and wire sizes is necessary to enable identification of trade-offs. Heavier wire sizes require heavier support structures. Current flow limits may force reduced train performance. The wire sizes will influence catenary system costs, and hence should be identified prior to the decision to electrify.

1.5.2.5 Mast Spacing

The mast spacing depends on catenary wire characteristics, wind loads, ice loads, track curvature, etc. Spacing may have structural implications for the masts, forcing reiterative evaluations. Computer programs to perform the analysis will be needed.

1.5.2.6 Low Clearance Situations

Many overhead restrictions will occur, e.g. highway and railway bridges, trusses and tunnels. In some cases these restrictions may have to be overcome through modifications to the structures in order to meet catenary requirements. This can only be resolved by specific reconnaissance of individual sites. However, this need not be unduly costly or time-consuming to produce a reasonable first estimate. To keep costs down, alternate means such as use of insulating shields would be desirable. Identification of the nature of these alternate means is essential.

1.5.2.7 Electrical Supply System

The design and location of the supply system is critical to the success of railway electrification. A major problem is unbalanced load and possible solutions, with an evaluation of costs, must be identified prior to the decision to electrify, since capital and operating costs can be significantly affected. Substation location must be optimized and a standard design adopted.

1.5.2.8 Signal and Communication Systems

The changes which must be made to railway track circuits are well known and present no problem. There are, however, several options available to reduce the electromagnetic interference with wayside communication wires and/or devices and these options will have to be evaluated for each specific rail line. Suppression of interfering signals at the source may be the preferred option in areas where non-railway communication equipment is nearby, whereas shielding and

burial of railway signal and communications wires is usually the preferred option in more remote areas. Negotiations will have to be undertaken with neighbouring communication companies before any decision is made.

1.5.2.9 Locomotive Maintenance Facility

Maintenance requirements for electric locomotives are substantially less and differ from those for diesel electrics. Evaluation of the maintenance work load, necessary spare parts inventory and the specification for the required facility will be needed. In so doing, recognition must be given to the interface -- either temporary or permanent -- with non-electrified portions of the system and the consequent possible requirement to also maintain diesel-electrics. Conversion of existing diesel shops to electric shops should be straightforward, but development of spare parts inventories and special tooling will be a longer process.

1.5.2.10 Catenary Maintenance Equipment

The equipment necessary for the maintenance of the catenary must be specified. This could include car- or locomotive-mounted television cameras or electronic instrumentation to inspect the catenary, special pantograph cars to test wire tension, registration and elevation while operating at high speed under the catenary, rail/road duel purpose trucks with aerial ladders, etc., and equipment to wash catenary insulators.

1.5.2.11 Transition by Dual-Mode Locomotive

It is possible to undertake partial electrification of main line track, and make modifications to the diesel locomotives so that either electric or diesel power may be used. This option is attractive to shorter rail lines with captive motive power such as the Quebec Cartier Railway. The more energy intensive sections of its 320 km of track could be electrified and its 18 locomotives modified with a relatively modest investment. In Ontario, however, partial electrification of main line tracks would accumulate to the point where equal investment would produce a completely electrified section which is long enough to make changes of motive power economical. Only with a dedicated section can one obtain the full advantages of electric motive power (i.e. higher power, higher adhesion and reduced maintenance). A dedicated section would also realize economies in fixed equipment maintenance and operational planning. Therefore, it is unlikely that electrification will occur in Ontario in a dual mode manner. Dual-mode locomotives may be useful as road-switchers on some branch lines, or on work trains.

1.5.3 Operations

Canadian railways are respected throughout the world as being both progressive and innovative. Over the past three decades and more they have led the way in many areas of technical and operational research and development. This does not mean, however, that change is adopted without sound evidence that such change will be not only beneficial, but also that it can be accomplished without adverse impact on daily operations.

Thus, in approaching such a major change as electrification, many questions arise regarding the security of operations. Some of them were propounded by a senior Canadian railway officer during an address he gave in 1973:

- Can I operate and maintain the system satisfactorily?
- What productivity improvement can I expect from the full electric locomotive as compared to the present or improved version of the diesel locomotive?
- What about anticipated maintenance savings; fuel or energy savings?
- What are the effects of the modern thyristor locomotive on the signalling and communications network?
- What is the economic life and availability of the electric locomotive?
- What are the train spacings related to catenary sections?
- What is the proper length of each catenary section to keep the operation flexible in event of local power interruption?
- What traffic flow interruption times due to the power failures should be added to those arising from all other causes?
- What arrangements are necessary to continue traffic flow during power interruptions?
- What will be the maximum load dimension after electrification?

Today, seven years after the asking, the bulk of those questions -- and others -- remain unanswered. An adequate response to some can be derived through an orderly and comprehensive study plan, some components of which are the economic, financial and technical issues identified earlier in this section. The precise response to others will only be derived after operations have commenced; that is to say, will only be derived by experience. Until then, answers can only be based on the best judgment of qualified operating officers acting on the basis of advice from technical specialists.

A problem of transition not yet discussed is that of operating the partially electrified system. This in fact is a series of problems, some of which are:

- to achieve maximum utilization of motive power -- both diesel-electric and straight electric. This is made difficult when two portions of a system upon which diesel locomotives are still being operated are separated by a portion which has been electrified.

- to minimize locomotive maintenance costs. Again, the interposing of an electrified section can create difficulties by isolating some of the diesel locomotives from maintenance and repair facilities. Fortunately diesel locomotives can be operated under a catenary and so they can always be utilized as power over the electrified section in order to gain access to the shop for planned maintenance. In the case of a need for unplanned shop attention, dead-head movement over the electrified section may be necessary. Other problems related to locomotive maintenance can arise when it becomes necessary -- at least temporarily -- as electrification progresses, to maintain both diesel-electric and straight electric units in the same shops.

- to minimize delay changing locomotives in a train from one type to another at the beginning and end of electrified sections. Related to this is the necessity to have locomotive engineers qualified in operation of both types.

None of these problems are insurmountable, as is evidenced by the successful operations of railways throughout the world, almost all of which are in fact operating partly electrified systems. Despite all efforts it is nevertheless apparent that inefficiences will exist in the early stages.

As is apparent, much remains to be done before the physical work of conversion can be commenced; nevertheless, neither technical nor operational feasibility is in question. Assuming suitable financing can be arranged, the question is "when," rather than "if," electrification of Canadian railways will commence. It is thus appropriate to emphasize the importance of careful selection of the first section to be converted. It should be representative in terms of traffic and terrain -- not the most difficult section but certainly not one without problems. As has been noted above, not all questions will be answerable in advance, especially those related to optimum operation, and the probable necessity for changes to certain of the early assumptions made as operating experience is accumulated needs to be recognized. Careful planning in this respect will expedite the ultimate introduction of the benefits of electric operation to all of Canada.

2. ECONOMIC EVALUATION METHODOLOGY

2.1 GENERAL

In the Ontario context, railway electrification involves a permanent state change in the operation of existing railway lines. Basically, an initial investment in an electrical power distribution system and other changes in fixed plant must be made. Against this are annual savings in locomotive maintenance labour and in energy cost. In addition to these basic costs and cost savings, railway electrification offers the opportunity for other changes in operating policy, with any attendant cost savings and/or improved service capabilities, including an increased ability to move traffic.

For the financial evaluation of electrification, the problem is one of assessing the benefits to the railway company which undertakes the electrification investment. The level of initial investment is relatively fixed, being basically dependent on the physical attributes of the line to be electrified, and, to a more limited extent, on expected traffic levels. Annual cost savings depend directly on annual traffic levels and the cost levels prevailing in each year. In the current context, with traffic growth and cost escalation, annual cost savings will grow over time. In fact, much of the recent North American interest in railway electrification has been predicated on the rapidly increasing prices of diesel fuel and the growing divergence between electricity and oil prices, both in absolute and relative terms. Thus, the financial evaluation of electrification must explicitly consider the factors of traffic growth and (differential) cost escalation.

Since the electrification decision is one of a permanent change, provision must be made for both replacement of the new fixed assets at the end of their economic lives and for incremental expansion of the electrification-necessitated assets as warranted by increased traffic. This is not to imply that electrification would not be reversed, but merely that once the decision to electrify is made, there is a new status quo that must be maintained until an investment decision in some alternative form of motive power is made, be it a return to diesel (or steam!) operations or the adoption of some new technology. Thus, more than the initial capital expenditures required to effect the conversion to electrified operations must be included in the financial evaluation. Since future motive power conversions cannot be foreseen at this point, the incremental investments and cost savings for the life of the railway must be taken into account.

A simple assumption that the impact of electrification on railway corporate cash flow will be confined to the costs applicable to a specified level of traffic in a particular segment is not strictly correct. Electrification, with its

characteristic initial capital cost penalty, followed by reduced operations costs, would influence the marketing function, and permit the solicitation of additional traffic volume at lower tariff levels. Theoretically, this adjustment should generate increased net benefits to the railway concerned. In practice, however, the overall impact may be negative.[4] An operations cost reduction, for example, would inevitably elicit reaction from regulatory authorities and the railway's customers and competitors. When rates were renegotiated, one could expect that an astute customer would attempt to capture some of the cost savings for himself in the form of lower real tariffs or expanded service. Competitive systems and modes could also be expected to react by adjusting their marketing strategies.

While the preceding is only a very simplistic outline of a very complex market mechanism for setting of transportation rates (further illustrated in Figure 4), it nevertheless outlines one of the financial problems that will be faced by the railway company which chooses to electrify:

> some of the benefits of lower operating costs due to electrified operations can be transferred from the carrier to shippers through the pricing mechanism.

The financial implications of this are obvious. For electrification to be an attractive investment for a railway company, the operating cost savings must be more than sufficient to provide an adequate return on investment. The balance of these savings will not provide a measure of real economic profit to the railway, but a real gain to the overall economy.

The increase in system capital intensity that electrification will bring, and the pattern of benefits growing over time, would certainly exert a more complex influence on corporate financing costs.

The impact of risk is important. Petroleum prices must be expected (in the statistical sense) to escalate differentially, and traffic is expected to grow. But expected value is only one parameter describing a probability distribution. Electrification represents a substantial relatively definite investment commitment, and the return is very long term. When the evaluation is based on expected value returns, as the alternative methodologies considered in this report are, it must be remembered that the negative impact of returns below expectations (in the extreme, insolvency), is far greater than the positive

4 The enormous cost savings, generated by conversion from steam to diesel were never realized as added profit to the railways (see testimony of Donald Gordon and Norris Roy Crump before the Royal Commission on Transportation, 1959-60 (MacPherson Commission), Vol. 10, 26, et seq.).

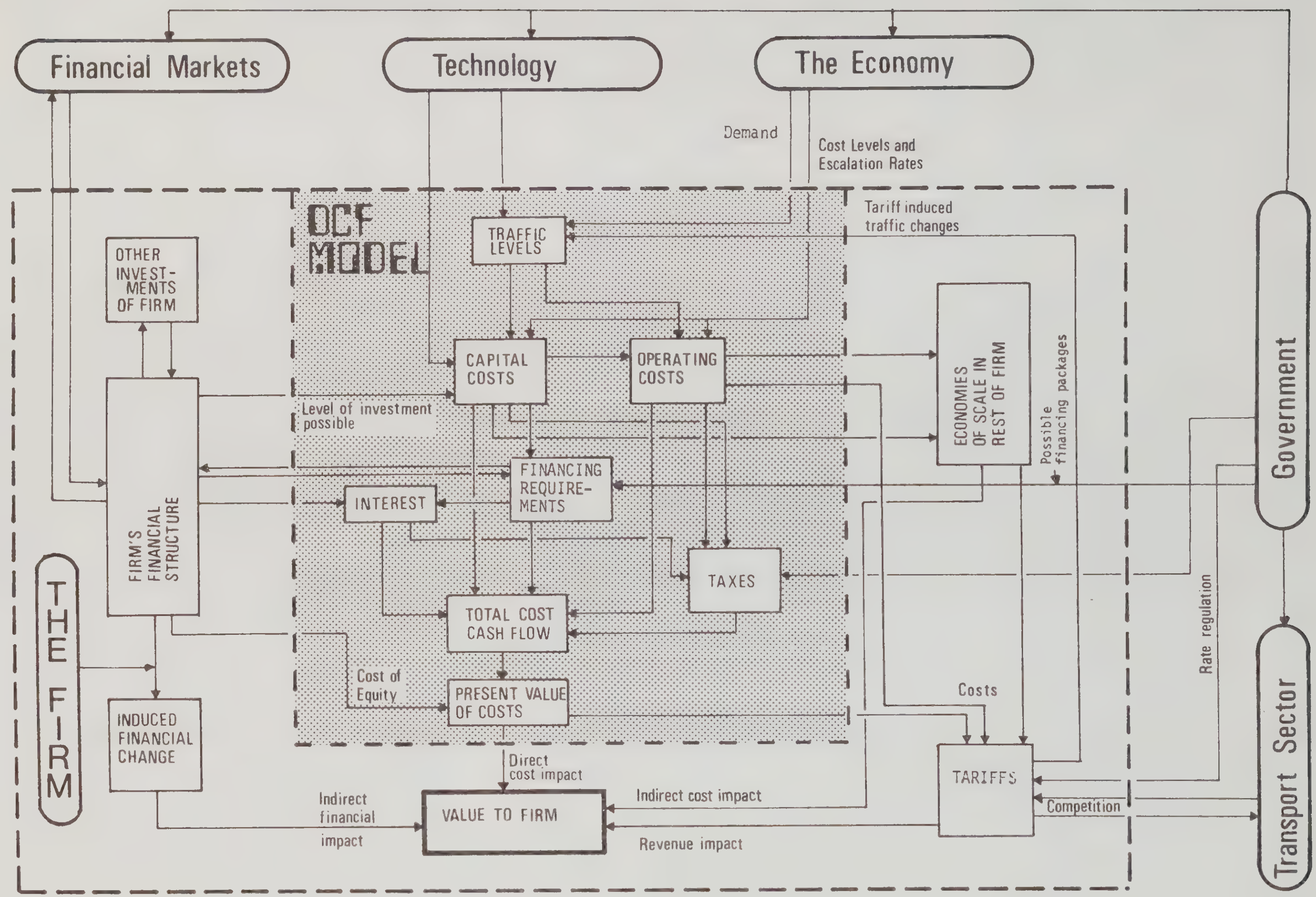

Figure 4 The incremental present value cost savings criterion, and value to the railway firm

impact of savings that exceed expectations (commonly referred to as excess profits).

For the option of electrifying the GO Transit lines in the Metropolitan Toronto area, the situation differs substantially from that of CN and CP lines. GO is operated by the railways for the Government of Ontario on a contract basis, with ticket prices and revenues being controlled by GO management and the deficit being covered from the public treasury. Here the leakage of benefits will not be of as great a concern. It may even contribute to the governmental objective, but the increase in risk implicit in increased capital intensity, and the vulnerability to swings in traffic, will still exist. In the GO context, a full-recovery ticket cost equivalent model, described briefly at the end of this chapter, should be the most appropriate.[5]

Revenue effects, corporate financial objectives, and competitive demands for funding (illustrated in Figure 4) have not been identified as such. For the present study, two economic criteria are selected. The incremental present value of first order direct cost savings (IPV)[6] is simply the present value of the cash flow implications of the first order direct cost savings arising out of the electrification decision -- initial capital, sustaining capital, diesel locomotive savings, operating cost savings and changes in corporate income tax -- without reference to who gains from any benefits.

The IPV criterion is augmented by the use of a capitalized payback period (CPP) defined as the expected number of years of electrified operations required to recover the initial conversion investment, while providing an acceptable return on the incremental investment. Put a different way, the capitalized payback is the expected number of years required for the present value of operating cost savings to exactly equal the present value of the initial capital investment. In contrast to the IPV measure which focusses on the magnitude of the overall cost savings due to electrification, the CPP focusses on the timing of the benefits and the impact on risk. The shorter the CPP, the lower are the chances that future (unforeseen) changes will cause the electrification investment to be a losing proposition. An important hurdle for CPP is the useful life of the new assets required for electrification. While cost savings benefits will continue to grow due to traffic growth and cost escalation, replacement and refurbishing of assets will be necessary. If the initial investment is not recovered before the first major replacement cycle begins, the CPP will be substantially

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5 The time limitations of the present study precluded the use of this methodology.

6 For convenience, this is somewhat abbreviated to incremental present value or IPV in the various figures and tables of this report.

increased, especially in cases where there is insufficient cash flow to cover the replacement capital expenditures as they occur.

In addition to the cost savings arising out of electrification which accrue to the railways and others in the transportation sector, there may also be benefits to the wider economic community. The theoretical impact of lower transportation costs are well known. Not as well defined are the industrial benefits of the purchase of new capital goods and the savings in petroleum use. These topics are briefly addressed in Section 6.

2.2 ERAIL EVALUATION METHODOLOGY

The basic concept of discounting annual costs and benefits is quite sound. Most discounted cash flow methodologies, however, do not adequately address the relevant aspects of traffic growth and differential cost resolution and accordingly are not suitable for railway electrification analysis. Thus, it was necessary to develop a new valuation model as a framework for consideration of the impact of various factor estimates on the economic attractiveness of electrification. The ERAIL model, developed for CIGGT's previous electrification study,[7] has several features, including differential cost escalation, growth factors incorporating exponential decay, and cost variability. These represent substantial departures from a more usual project evaluation procedure, but generate more appropriate results.

The model, as developed, generates an equivalent present value of cost savings for incremental corporate investments of sufficient size to warrant individual attention with respect to (debt) financing. The accounts of the new venture are assumed to be consolidated with those of the existing enterprise, and overall corporate profits to be sufficient to cover any capital cost allowances generated by the increment investment. It does not address the revenue impact and broader financial considerations. The aggregate of functional relationships that constitute the model are briefly outlined in the following sections.

2.3 DIFFERENTIAL COST ESCALATION

The assumption that differential rates of cost escalation will influence the investment decision is central to the development of the model. Without differentials, the effects of factor substitution when component costs exhibit different rates of escalation could not be discovered.

7 "Canadian Railway Electrification Study," op. cit. The full ERAIL model development is described in Chapter 10.

In addition to aspects concerning differential escalation, general inflation has a significant impact on the viability of a capital investment. Even if revenues and costs were to escalate at a constant rate, interest and debt retirement are defined by contract, and will be payable in legal (as opposed to real) dollars. Similarly, capital consumption allowances are defined in terms of historical costs, and the tax shelter they provide is insufficient to cover the real value lost.

The use of simple (geometric) differential cost escalation rates over the long run gives incorrect results. Input substitution encouraged by divergent factor prices will tend to have an effect on the rate at which these prices diverge. Thus, it is only reasonable to presume that, following an economic disturbance that establishes a differential, escalation rates will tend to gravitate towards a common level. Accordingly, the model is designed to allow differential escalation rates for individual cost components to decay towards some constant level.

Continued or accelerated inflation manifests itself as a benefit to be gained by making the capital investment, introducing yet another consideration. While some degree of continued inflation over the intermediate term would seem inevitable, predicating the economic viability of an investment alternative on an assumption of constant or growing inflation is scarcely conservative. If a model is to serve its role, it must correctly simulate the corporate decision process. Thus, as an approximation, cost escalation rates have been decayed towards zero. It should be noted, however, that for cases where continued inflation constitutes a disadvantage to the firm, this procedure should not be used if a conservative approach is to be maintained.

Accordingly, cost component prices have been escalated on the basis of

$$P_{ti} = (P_{t-1,i})(1+\text{DINF})(1+\Delta P_i e^{-\alpha(t-1)}) = \prod_{t'=0}^{t-1} (1+\text{DINF})(1+ P_i e^{-\alpha j})$$

where: P_{ti} = the price level of an item of class i prevailing in year t (relative to the price level in year 0)

DINF = the general rate of inflation

ΔP_i = the cost escalation rate differential applicable to items in class i, either above or below general inflation

α = an escalation decay parameter.

The model does not give separate specific consideration to the cost mitigation effect exerted on the effective escalation rates by technological advancements,

increased managerial efficiency and simple learning. While this learning process does not decrease the actual cost escalation rate, the ability to produce the same output with progressively less of an input factor produces the same effect. As the opportunity for such mitigation varies with the nature of the activity implied by the cost category, the effects must be considered in the escalation rate selection process. The appropriate net differential escalation rate becomes

$$\Delta P_i = \frac{i + \Delta C_i}{1 + H_i} - 1$$

where: ΔP_i = the appropriate (net) category differential cost escalation rate

ΔC_i = the weighted average of the rates of escalation in the price of the inputs included in the cost category

H_i = the appropriate category cost mitigation factor.

2.4 TRAFFIC VOLUME GROWTH

Where growth of output is a significant determinant of overall costs and benefits, development of a satisfactory long-term model can be complicated. The use of a simple growth factor might seem reasonable for short-term estimation, but an assumption of unbounded geometric growth over the longer term would lead to ridiculous projections and spurious conclusions. Thus, it is necessary to model some long-term limitation of the growth process.

In the transportation context, economic growth results in a corresponding increase in transportation sector activity. As an economy matures, however, it is not reasonable to expect real growth in transportation to keep pace with the overall economy. A brief analysis of Canadian railway statistics[8] confirmed the significance of a decay relationship in that context.

Accordingly, growth was modelled to decay exponentially towards some limit. Thus, the volume growth index for any time period is given by

$$V_t = \prod_{j=0}^{t-1} (1 + \Delta V e^{\alpha j})$$

8 Railway tonnages were regressed against Real Domestic Product. Parameter estimation for an exponential decay form of model indicated (with 95 per cent correlation) railway traffic growth to be a declining proportion of real product growth.

where: V_t = traffic volume in year t

ΔV = the expected simple growth rate trend

α = a decay parameter.

For simplicity, a linear relationship between volume and costs was assumed, and the effect of volume on costs and cost savings was modelled using a cost variability factor (λ) in a general form of

$$C_{ti} = C_{0i} + \lambda_i (V_t - V_0)$$

where: C_{ti} = the cost for category i in year t

C_{oi} = the cost for category i required by base-year volume levels

V_t = the volume growth index in year t.

By this procedure, economies of scale were accommodated. The effect of volume on certain categories of infrastructure capital costs was more difficult to model, as large expenditures will be required when output reaches certain (ill-defined) density thresholds. Because of this lack of definition, rather than modelling such "lumpy" costs as a rather arbitrary step function, they were represented by sinking fund payments made, for example, to a fixed asset expansion account. (A typical sinking fund approximation to a step function is shown in Figure 5).

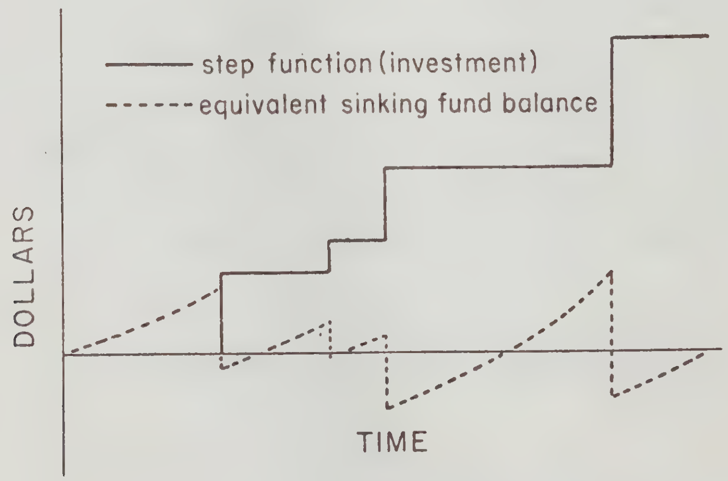

Figure 5 Sinking fund approximation to an investment step function

2.5 CAPITAL EXPENDITURES

Annual capital expenditures are a function of the cost escalation rate, the output growth rate and the level of expenditure (in unescalated, base year dollars) required to service the output in the base year. The functional form

of the capital expenditure equation varies slightly with the nature -- initial, incremental expansion, or replacement -- of the expenditure.

Initial investment expenditures, adjusted for design year output levels, are given by

$$C_{ti} = (B_{ki})\ (P_{ti})\ (1 + \lambda_i(\hat{V} - 1))$$

where: B_{ki} = capital outflows for asset class i, drawn down in the kth year (current dollars)

P_{ti} = appropriate cost level (asset class i)

λ_i = the cost variability factor for asset class i

$\hat{V}$ = index of volume projected for the design year.

Following the commencement of operations, the stock of capital goods must be expanded to keep pace with output demand. For certain classes of goods this represents annual incremental expansion, while for other classes it represents payment to an expansion account (discussed under "Traffic Volume Growth").

As incremental expansion outflows will remain small in relation to initial expenditures, they are not drawn down into an investment schedule, and are given by

$$(\sum_k B_{ki})\ (P_{ti})\ (\lambda_i(V_{t+1} - V_t))$$

Since a permanent conversion state change is being modelled, capital assets are automatically replaced at the end of their service lives. Allowing for a residual (salvage) value at some fraction of replacement cost, the replacement component capital outflows are computed by

$$(1-S_i)\ (C_{t-n_i,i})\ (P_{ti}/P_{t-n_i,i})$$

where, in addition to those variables already defined,

S_i = the expected salvage value of assets in class i as a proportion of replacement cost (for the first replacement only)

n_i = the service life of assets in class i.

2.6 FINANCING AND CAPITAL CONSUMPTION ALLOWANCE AND OPERATING COSTS

Since the model examines an incremental investment within an existing larger corporate structure, the financing of capital expenditures is assumed to follow the firm's existing structure. Thus, capital expenditures are financed according to a simple, fixed debt/equity ratio with debt retired in equal increments over the life of the asset in a manner similar to "straight line" depreciation. Annual interest is assessed on outstanding debt balances. While this treatment precludes the examination of individual financing alternatives and incremental impact on total corporate financing, it is reasonable in the incremental context. Capital consumption allowances for income tax purposes are determined on a declining-balance basis as stipulated by Canadian tax law. Again, it is assumed that overall corporate income is sufficiently large to cover all tax savings so generated.

The model's treatment of operating costs is similar to that of capital costs. Operating cost components are given by

$$O_{ti} = (B_i)\ (P_{ti})\ (1 + \lambda_i(V_t - 1))$$

where: B_i = operating cost for component i to serve base year volume, in base year price levels

P_{ti} = the appropriate cost level for operating cost component i in year t

λ_i = the cost variability factor.

2.7 TOTAL INCREMENTAL PRESENT VALUE AND CAPITALIZED PAYBACK PERIOD

The sum of all after-tax cost flows arising from the incremental investment -- both costs and savings -- discounted at the appropriate cost of equity, yields the incremental present value (IPV) to the firm. If cash flows which represent a cost savings to the firm are positive, and those which represent an incremental cost are negative, a positive IPV indicates a net incremental savings. The capitalized payback period is determined from the annual discounted cash flows.

The general equation is

$$IPV = \sum_t \frac{\sum_i (C_{ti} + R_{ti}) - D_t + (1-T) \sum_i O_{ti} + (1-T)\ I_t - T(CCA_t)}{(1+k_e)^t}$$

where: k_e = the cost of equity

D_t = the annual net change in debt

T = the marginal corporate income tax rate

I_t = the annual incremental interest expense

CCA_t = the annual capital consumption allowance.

As the investment decisions being analyzed represent a state change which can only be made once, the determination of an optimal investment timing is important. To properly represent the conditions of a state change, the model must be applied to infinity.[9]

2.8 UNIT TICKET COST APPROACH

The Toronto-Montreal high-speed passenger study (Section 4.3.2) employed the MRAIL[10] methodology, and similar treatment would be appropriate for GO Transit. In many ways -- differential cost escalation, etc. -- the MRAIL approach is similar to ERAIL, but there are important differences. Essentially, MRAIL takes the full spectrum of system cash flow requirements and generates a full cost recovery schedule of unit costs; in the case of passenger systems these are ticket costs.

It starts with estimates for all cost components in terms of base year price levels, but rather than discounting the costs to determine the incremental present value of a project, it generates the revenue required per unit of output, subject to two constraints. First, it must be financially feasible (projected cash flow requirements including debt service must be met annually); secondly, the net present value of an acceptable return on equity must be zero. The output is a schedule of real (constant dollar) full recovery ticket costs over time, and a single number ticket cost for comparative sensitivity analyses.

In the context of evaluating an electrified GO Transit, this approach would take the full spectrum of cash flows for the system without electrification, and similar figures (including a first estimate of a schedule of annual passenger demand) for the electrified alternative. Full cost recovery ticket cost schedules for each would be calculated and compared, and the resultant ticket price implications used to modify the electrified GO demand forecasts appro-

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9 Since the cost escalation and output growth functions P(t) and V(t) tend to a limiting value as time increases, infinity can be conveniently approximated since $P(t).V(t/(1-k_e)^t$ will approach zero in a finite time span.

10 See R.W. Lake, C. Schwier, J.A. Macdonald, "Evaluation of Modal Alternatives on the Basis of Transportation Unit Cost Schedules," Logistics and Transportation Review, Vol. 15, No. 12. The published version does not include differential escalation.

priately. A second run should be sufficient to provide a ticket cost schedule for evaluation.

Such a procedure, while recommended, is outside of the scope of the present study, and hence the ERAIL treatment has also been applied to GO Transit.

3. ELECTRIFICATION OPTIONS FOR ONTARIO

Previous studies of railway electrification have shown that the annual traffic volume must be substantial if a railway line is to be an economically attractive candidate for conversion to electrified operation. However, absolute tonnage is not the only traffic-related determinant. The additional power available in electric locomotives makes them particularly well suited for passenger service, and, to a lesser extent, for express freight service, so that a line on which passenger and express traffic make up a significant proportion of total tonnage is a better candidate for electrification than a similar line carrying the same total tonnage of general freight only. Canadian mainline track typically carries substantial volumes of passenger and express freight as well as major flows of general freight.

Traffic levels on Ontario rail lines were used to identify potential candidates for inclusion in an electrified network. Lines carrying at least 10 million gross tons (MGT) annually[11] were selected for further consideration. In fact, traffic on most main lines was either well above this figure ($\geq$ 20 MGT) or well below ($\leq$ 4 MGT).

A limited number of lines with relatively low traffic volumes, which would not be logical candidates for electrification if considered in isolation, were included to facilitate the interconnection of major links in the potential electrified railway network.

The candidates for inclusion in such a network (summarized in Figures 6 and 7 and Table 6) include the CN and CP main lines from Montreal to Toronto and through to the U.S. border at Windsor and Sarnia, and the CN and CP main lines connecting Toronto to Winnipeg and beyond. The CN and CP lines running from Montreal directly to Nortern Ontario through Ottawa were also included as were lines giving access to the Niagara peninsula and the Lake Erie shoreline, and some secondary lines which provide alternative paths to portions of the selected main lines. In addition to these intercity lines, the GO Transit service in the Toronto area (which is operated over the metropolitan sections of CN and CP lines, as shown in Figure 8) was included as an electrification candidate.

Although gross tonnage and the mix of train types provide useful first-order criteria for the selection of candidate lines, they are not sufficient to ensure the success of electrification. The nature of the traffic flows across each line, and especially the origin and destination of these flows, must be considered. For example, a substantial mainline flow which feeds into a number of

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11 Total annual traffic in both directions including payload, tare weight of loaded and empty cars and weight of locomotives.

TABLE 6

POSSIBLE ONTARIO ELECTRIFIED ROUTES (BUILDING BLOCKS)

Segment	Railway	Route	Nominal Route Miles	Rough Tonnage Estimate
1	CN	Montreal to Toronto	330, double track	37 MGT
1(a)	CN	Montreal to Toronto with through passenger on new line	330, double track (freight) 370, double track (passenger)	32 MGT plus passenger trains
2	CN	Toronto-Sarnia	173, double track	25-40 MGT (varys by track section)
3	CN	Toronto-Capreol	260, single track	17 MGT
4	CN	Capreol-Winnipeg	927, single track	20-25 MGT
5	CN	Thunder Bay-Winnipeg	432, 90% single track	22-32 MGT (varys by track section)
6	CN	Montreal-North Bay*	420, single track	10 MGT
7	CP	Montreal-Toronto	350, partial double track	20 MGT
8	CP	Toronto-Windsor	220, partial double track	n/a
9	CP	Toronto-Sudbury	255, single track	n/a
10	CP	Sudbury-Thunder Bay	550, single track	20 MGT
11	CP	Thunder Bay-Winnipeg	420, double track	44 MGT
12	CP	Montreal-Sudbury†	440, partial double track	10 MGT
13	GO	Transit lines electrified alone	see text	see text
14(a)	ONR	North Bay to the north	317, single track	5.5 million <u>net</u> tons (see text)
14(b)	CN	London-Windsor	98, 80% double track	11 MGT
14(c)	CN	Longlac-Thunder Bay	200, single track	3.5 MGT
14(d)	CN	Superior Junction (Sioux Lookout) -Thunder Bay	150, single track	5 MGT
14(e)	CN	Hamilton-Niagara Falls/Fort Erie	see text	see text
14(f)	CN	Toronto-North Bay	225, single track	4-8 MGT
14(g)	Various	Detroit-Niagara Falls/Fort Erie	see text	see text

* uses same track as Segment 1 between Montreal and Coteau
† uses same track as Segment 7 between Montreal and Smiths Falls

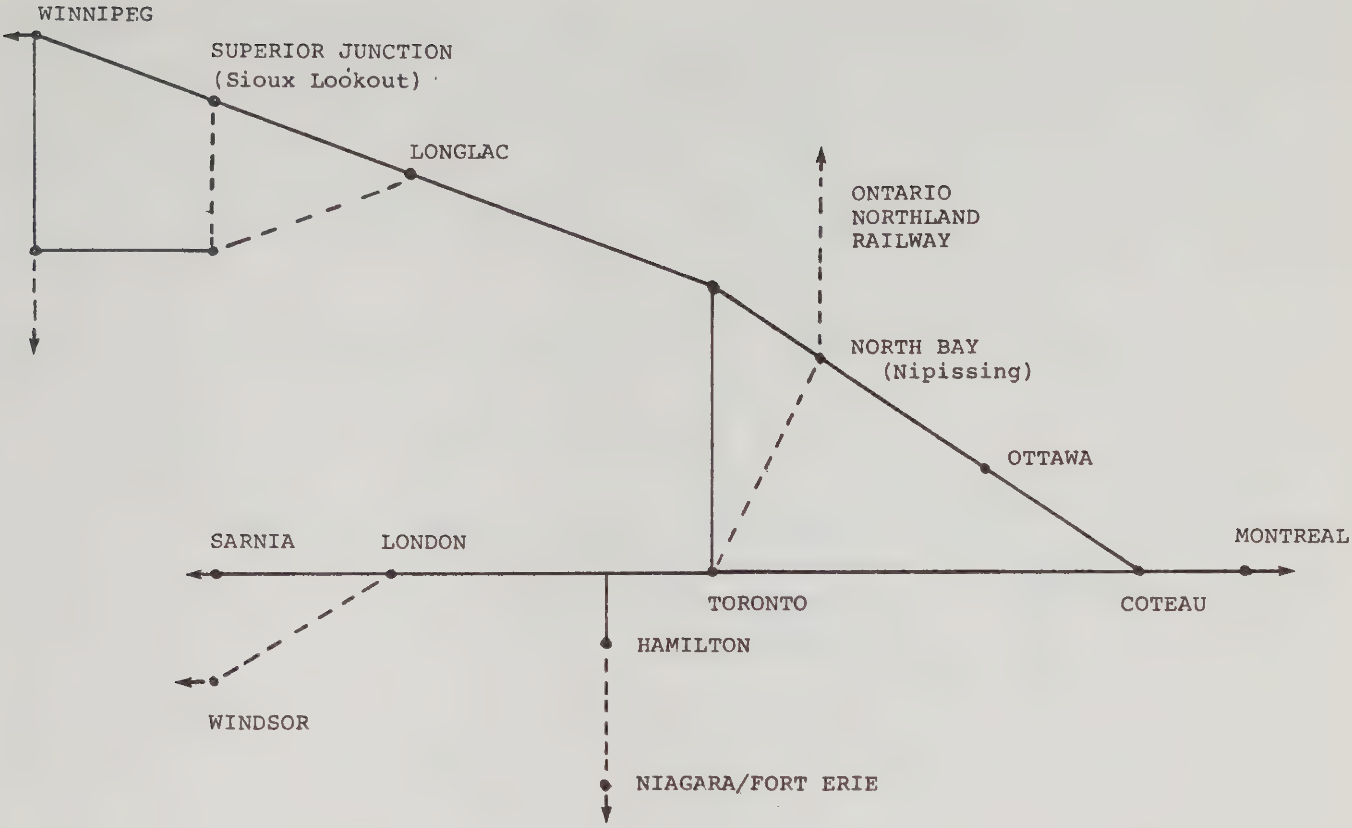

Figure 6 Canadian National mainline trackage for possible electrification in Ontario

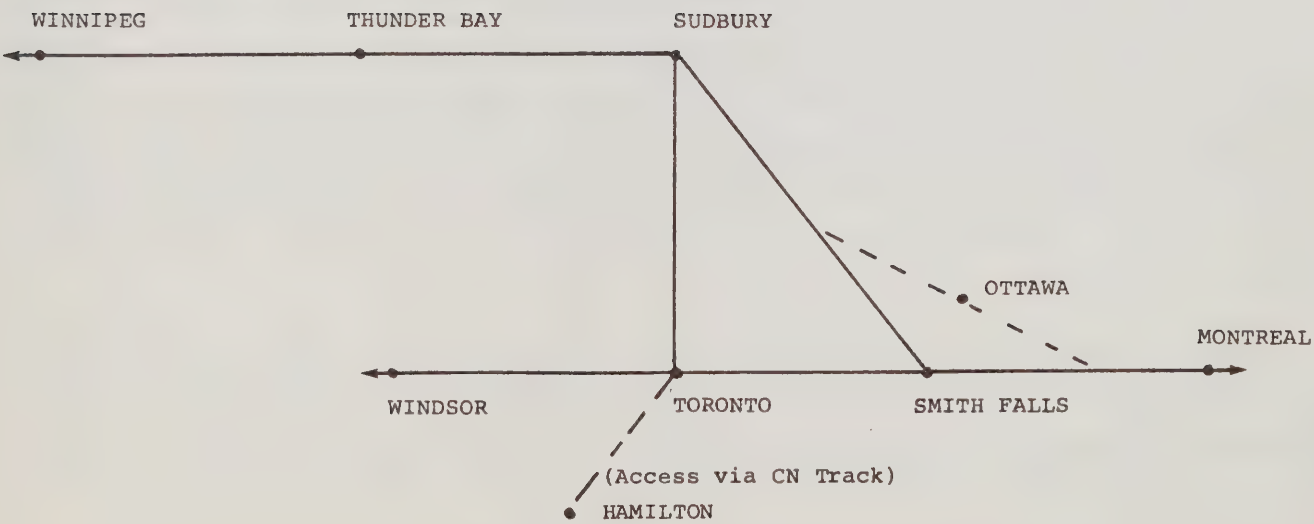

Figure 7 Canadian Pacific mainline trackage for possible electrification in Ontario

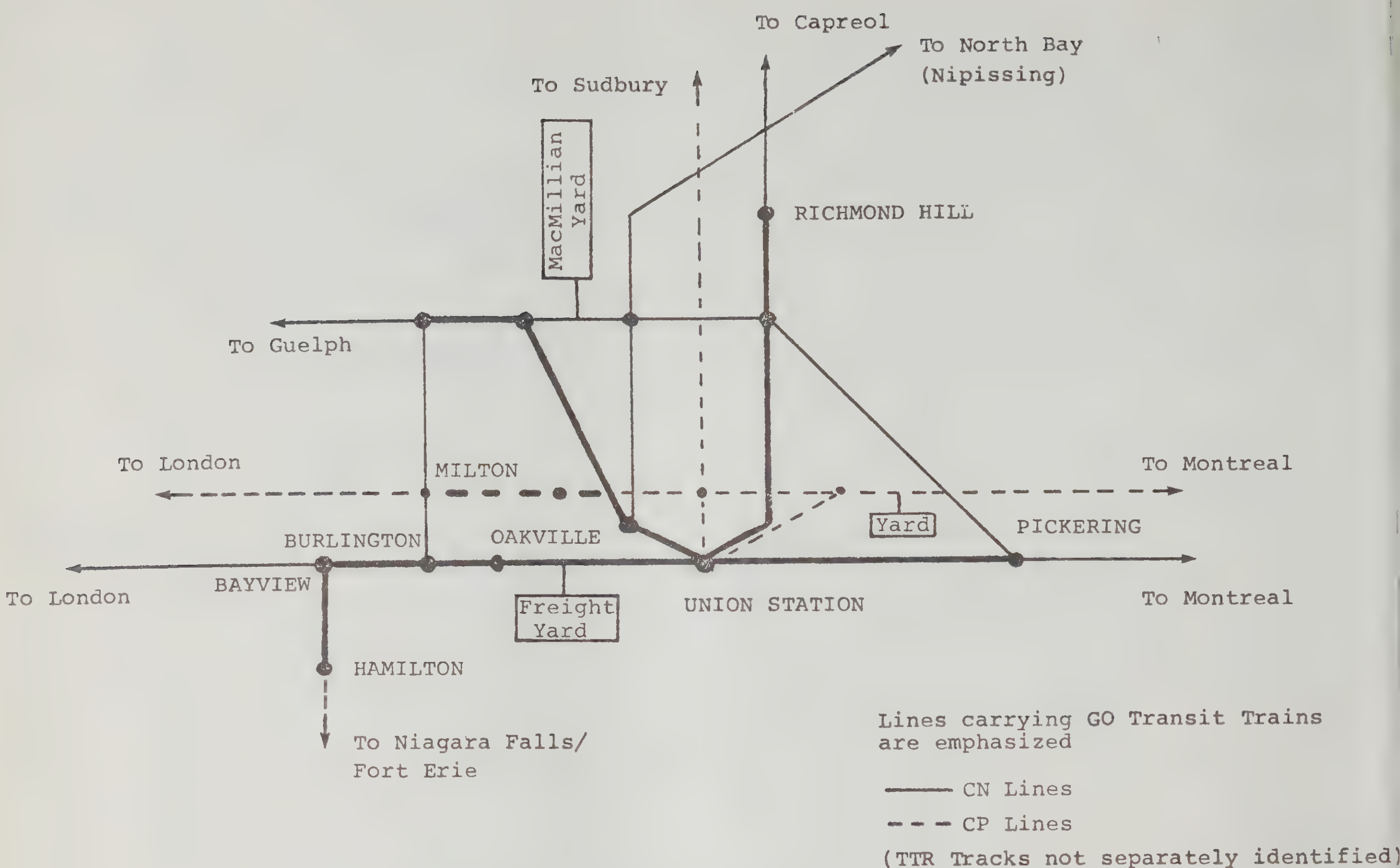

Figure 8 Details of railway track in Toronto area showing GO Transit Routes

lower-density branch line distributaries will present a number of problems. Trains may originate within a single area, thereby providing adequate tonnage and train-type mix to justify electrification of the spinal portion of the network, but the benefits of electric operation would not be available unless each branch line was also electrified. The additional fixed cost of catenary installation on these lower-density lines could make the overall investment questionable. Of course, the main line could be electrified and the motive power changed for branch line operation. However, this would require additional motive power depots, an increase in locomotive inventory, and increased labour and fuel costs, all of which must be charged against the savings arising from electrification.

The other alternative would be to continue operating trains which leave the main electrified line entirely with diesel power. However, this would reduce the potential savings of electrification without any corresponding reduction in the level of fixed plant expenditures.

Similarly, local traffic and way freight operations could not be handled with electric locomotives unless every spur track and industrial siding were filled with catenary. In most cases, this traffic is quite insignificant, and could not begin to justify the additional capital outlay. Diesel power would be

retained for trains providing service to such locations. However, where a particular site generates significant traffic, and is served from the main line, rather than from a yard, short stretches of slow-speed, lower-cost catenary (trolley wire, in effect) could be installed. This situation would prevail at the Lennox Generating Station. When the Ontario Hydro facility is in operation, train-load lots of residual oil are delivered from Montreal several times weekly.

3.1 A LIST OF POTENTIAL SEGMENTS

Segment One - CN Montreal-Toronto

The basic Montreal-Toronto route (downtown to downtown) is 340[12] miles, fully double-tracked, carrying 35-40 million gross tons in 1979. Both express and passenger traffic are significant. In the Montreal area, an additional 10 million gross tons of traffic is handled for transfer to the line to Northern Ontario through Ottawa. At Pickering the line splits, with the bulk of freight being routed over a 25 mile, partially-double-tracked line to the MacMillan yard. Between Pickering and downtown Toronto there are also 30 commuter trains per day (GO Transit) in each direction.[13] Given current operating procedures, electrification of this segment would require catenary on both routes into Toronto. The GO Transit commuter operations could not run electrically unless more than the Montreal-Toronto segment is electrified.

Segment One-A - CN Montreal-Toronto (without through passenger traffic)

About 12 per cent of the tonnage on this line is passenger traffic. One option for the future is the replacement of most of this traffic with a new dedicated high-speed passenger line directly serving Toront-Ottawa-Montreal.[14] Except for catenary on a few miles in and around the passenger terminals in Toronto and Montreal and (possibly) some passing sidings, the initial capital expenditures savings would not be significant. Cost savings, per mile of catenary, would be reduced to a greater extent. The proposed passenger line is a good candidate for electrification.

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12 CN's downtown Toronto freight terminal is 8.4 miles (four tracks wide) west of Union Station.

13 Track in the Union Station area is under the control of the Toronto Terminal Railways, a joint subsidiary of CN and CP.

14 R.W. Lake, C.J. Boon, G.W. English, C. Schwier, C. Fitzpatrick, P.M. Bunting and A.R. Eastham, "Alternatives to Air: A Feasible Concept for the Toronto-Ottawa-Montreal Corridor," CIGGT Report No. 80-4, in preparation.

Segment Two - CN Toronto-Sarnia (Windsor)

Going west from Toronto also requires electrification of a forked route in Toronto. The main line from the MacMillan yard is 172 miles, double-tracked, from Union Station (164 from downtown freight terminal) to Sarnia; the freight connection is 47.5 miles, double-tracked, from MacMillan Yard, joining the main line at Burlington. Traffic levels are variable through the route. About 30 million gross tons are handled between MacMillan Yard and Burlington. Between Burlington and Bayview (connection for Hamilton)[15] traffic is more than 60 million tons. (Much of this is Canadian Pacific traffic under running rights.) Traffic to London is in the order of 35 million tons, about 14 per cent of which is passenger. Express traffic is of little significance. West of London (Komoka) the bulk of the freight traffic runs over 50 miles of double track to Sarnia, while most of the passenger traffic runs over a different 100 miles to Windsor. On the Toronto-Oakville segment there are about 30 GO trains per day in each direction, with an additional four GO trains running into Hamilton.

Electrification of the CN Toronto to Sarnia segment presents certain complications due to the nature of the traffic. Much of the tonnage between Toronto and Hamilton is Canadian Pacific traffic. To convert these would require extension of catenary to CP's freight yards on the eastern edge of Toronto and in Hamilton, or two expensive changes of motive power.[16] A considerable portion of this CP traffic and CN's traffic between Toronto and Hamilton is dispatched to the south without motive power changes, necessitating further electrification. A similar situation exists at the west end of the segment where traffic is split between Sarnia and Windsor. In addition, there is significant "local" traffic which will (in some combination) either lower the electrifiable tonnages or increase the investment in catenary.

Segment Three - CN Toronto-Capreol

The main CN line to the north (Bala Subdivision route) is about 275 miles (single-tracked) from Union Station. Unless other electrification projects have already been undertaken into Toronto, an additional 20 to 30 route miles would have to be electrified to connect this line with the various CN freight terminals. Basic freight traffic is 16 to 19 million gross tons, of which 5 million tons is express. Passenger traffic is negligible except for the current six GO trains per weekday between Union Station and Richmond Hill (21 miles). There is an alternative CN route to the north (segment 13E) which is 225

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15 The extra few miles between Bayview and Hamilton would form an integral portion of electrification of this segment.

16 Some of this would be saved if some of the CP lines to Toronto were previously or concurrently electrified.

single-track miles from downtown Toronto via the Newmarket Subdivision to Nipissing (North Bay), where there are connections for Ottawa, Capreol and the Ontario Northland Railway. Current traffic on this line is significantly under 10 million gross tons. Passenger traffic levels on this line are about double those on the direct line to Capreol.

Segment Five - CN Capreol-Winnipeg

The main line is 927 miles of single track passing through Hornepayne, Nakina and Sioux Lookout, with connections for Thunder Bay at Longlac and Superior Junction. Traffic levels range from 21 to 25 million gross tons annually, about one-third being express trains. Currently there is once-a-day (local) passenger service over this line. With the exception of primary products, there is little local freight traffic.[17] The two connections between Thunder Bay and the main line (Segment 14C at Superior Junction/Sioux Lookout and Segment 14D at Longlac) are about 200 single-track miles each. Freight traffic is in the range of three to five million gross tons with negligible passenger and express traffic.

Segment Five - CN Thunder Bay-Winnipeg

CN's Thunder Bay to Winnipeg link is a 432 mile (36 miles double track) line through Atikokan, Fort Frances and Rainy River. Traffic between Thunder Bay and Fort Frances is about 18 million tons (somewhat higher east of Atikokan), and between Fort Frances (Duluth Junction) and Winnipeg is 32 million tons. More than half of this tonnage is transferred to CN's line to Duluth (DWP Railway).

Segment Six - CN Montreal-Capreol

A shorter connection between the West and Montreal is CN's line through Ottawa and North Bay to Capreol. This is a 380 mile, single-track line joining the Montreal-Toronto main line at Coteau. Between Coteau and Ottawa, traffic is about 13 million tons, with significant passenger train volumes. West of Ottawa traffic falls off sharply. There is appreciable express train traffic throughout the route. The final passenger train configuration on this route is yet to be determined. If the current passenger trains were to be converted to electrified operations, an additional 14 route miles of catenary would have to be provided to give access to the Ottawa passenger terminal.

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17 For example, about three million tons originate or terminate at Bruce Lake and follow the main line for 60 miles to Sioux Lookout for dispatch to Thunder Bay.

Segment Seven - CP Montreal-Toronto

The CP Montreal-Toronto line is about 325 miles, running through Smiths Falls. The easternmost 128 miles are double-tracked. In Toronto an additional 15 to 20 route miles of catengary may be required to provide access to other than the main freight yard in Agincourt. Traffic is in the neighbourhood of 20 million gross tons.[18] Passenger traffic, except for twelve daily commuter trains in Montreal, is negligible, running over only short segments of this route.

Segment Eight - CP Toronto-Windsor

CP's route west from Toronto is a 220 mile high-quality line going through London to U.S. connections at Windsor. The 35 miles at the Toronto end which has some GO traffic is double-tracked. The line carries considerable freight tonnages, but unlike CN's parallel line, does not have as many branches which would also require conversion. If this were the first CP line into Toronto to be electrified, provision for catenary would have to be made for access to the various yards in downtown and Agincourt.

Segment Nine - CP Toronto-Sudbury

The CP link between Toronto and Sudbury is a 255 mile single-track main line carrying considerable freight and express traffic. There is a small amount of passenger traffic at the northern end of the line. Portions of the line pass through rough terrain and higher catenary costs will apply.

Segment Ten - CP Sudbury-Thunder Bay

CP's link from Sudbury to Thunder Bay is a 550 mile single-track main line with Centralized Traffic Control. Traffic is in the range of 20 million gross tons being fed from Montreal (via Smiths Falls) and Toronto. This is one passenger train per day in each direction over the whole line and a second over part of the distance. Again, different terrain will increase unit costs of catenary.

Segment Eleven - CP Thunder Bay-Winnipeg

The Thunder Bay to Winnipeg link is a 420 mile double-tracked line carrying 44 million tons per year. There is considerable wheat and other bulk traffic moving from the West to the Lakehead over this line, and it has good traffic growth potential.

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18 Current CP data not yet available; discussion is based on figures given in Chapter 8 of 1976 study.

Segment Twelve - CP Montreal-Sudbury

The direct CP link between Montreal and Northern Ontario uses the double-tracked Montreal-Toronto main line for 128 miles from the east to Smiths Falls, and rejoins the main line at Romford (six miles from Sudbury). The intervening 310 mile single-tracked line carries some 10 million tons of freight and one passenger grain per day in each direction. This line does not serve Ottawa, although there are connections, and a 113 mile secondary line from Montreal to Ottawa connects with this line at Carleton Place.

Segment Thirteen - GO Transit

The GO Transit system currently runs 30 commuter trains per day in each direction on CN's main line in downtown Toronto from Pickering to Oakville. An additional four trains per weekday go past Oakville into Hamilton. In addition, a few trains per day are run between Union Station and Richmond Hill, Union Station and Milton (CP lines) and Union Station and Georgetown. A number of electrification options are open. The first would be the Pickering-Oakville route. By itself, this would involve 44 route miles of double track, plus passing sidings, station trackage and service trackage. The additional trains that run into Hamilton could remain diesel-powered or be replaced by expansion of the existing GO bus system. The second option would involve the subsequent electrification of the additional 87 route miles used by the lower density GO traffic lines. While the capital costs of conversion per mile would remain similar, the operating cost savings would be significantly less due to the low traffic densities. Were various CN lines into Toronto electrified for intercity traffic, the incremental electrification of GO Transit could be carried out with little additional fixed plant investment.

Segment Fourteen (A) - Ontario Northland Railway

The provincially-operated Ontario Northland Railway is the largest of Ontario's Class II lines. It runs north from the junction with CN at North Bay through Temagami, Timmins and Cochrane to Moosonee. It has sometimes been proposed as a candidate for electrification. Traffic characteristics, however, militate against converting the ONR solely on the basis of cost savings. Total traffic handled throughout the system is five to six million net revenue tons (say 10 million gross tons), much of it interchanged with CN at either Rouyn, North Bay or Cochrane. Most of ONR's traffic uses the 243 mile spinal portion of the line between North Bay and Cochrane; however, an additional 100 miles of branch line electrification would be required to serve ONR's major traffic originators. Thus, possible electrified ton miles per mile of track would be in the range of four million, well below any economic threshold with foreseeable traffic growth possibilities. Electrification of only the higher traffic southern portion of

the ONR would involve either expensive motive power changes at Swastika or a decrease in the potential tonnage to be converted to electric operations.

4. FINANCIAL EVALUATION OF ALTERNATIVES

This chapter briefly presents the basic financial results of some of the electrification options described in the preceding chapter. Input costs and cost savings are, by necessity, rough estimates, since detailed designs and conversion plans are beyond the scope of this study, and have been drawn from previous electrification studies. Some attention has been paid to local conditions affecting costs on each of the lines examined.

Section 4.1 presents a brief summary extract of the forthcoming CIGGT study, "Alternatives to Air: A Feasible Concept for the Toronto-Ottawa-Montreal Corridor." This coverage of the high-speed electrified passenger railway option is presented first, not as any priority, but because the analysis was done with the more detailed MRAIL methodology. Section 4.2 presents general electrification cost and cost saving data, and the financial parameters used for the sample electrification possibilities examined with the ERAIL methodology. Of the subsequent sectons, again not in priority order, 4.3 describes the Winnipeg to Thunder Bay CP routing, 4.4 GO Transit, 4.5 the CP main line across Northern Ontario to Montreal and the CN route between Toronto and Montreal.

4.1 ELECTRIFIED TORONTO-MONTREAL DEDICATED PASSENGER SYSTEM

During the past two and a half years, the Canadian Institute of Guided Ground Transport, under contract with Transport Canada Research and Development Centre, has carried out an economic evaluation of high-speed passenger systems over selected routings linking Toronto, Kingston, Ottawa, Mirabel and Montreal.[19] The study examined the cost characteristics of high-speed or intermediate-speed railway services (HSR or ISR), Maglev and air (STOL and CTOL) in the corridor under three fuel cost/economic growth scenarios. The optimistic scenario assumed a two per cent growth in real disposable income and one per cent in real fuel price, with the status quo and pessimistic scenarios assuming one per cent and zero per cent real disposable income growth and three per cent and six per cent real increases in the price of petroleum fuel.

Two of the options considered were a 260 km/h (160 mph) electrified railway operating on dedicated double track and a similar system operating over a slightly different right-of-way at 200 km/h (125 mph). The high-speed (HSR) system was considered as one of the alternatives under optimistic and status quo scenario conditions, while the electrified 200 km/h (EISR) system was restricted

19 "Alternatives to Air: Designs for the Toronto-Ottawa-Montreal Corridor," CIGGT Report No. 80-4, in preparation.

to the pessimistic scenario. Diesel powered 200 km/h railway operations were among the other systems analyzed.

4.1.1 System Characteristics and Costs

The characteristics for the HSR and EISR systems are summarized in Table 7.

The HSR system infrastructure and rolling stock have been designed to operate at speeds of up to 300 km/h, although operations limited to 260 km/h have been assumed. The fully double-tracked line would be electrified at 50 kV, with a limiting curvature of 0°35'.[20] As projected demand would not require headways of less than twenty minutes, substation spacings of 100 km would provide adequate power. The HSR track structure design calls for 57 kg/m continuous welded rail on 2.5 m concrete ties, fastened with Pandrol clips. The minimum ballast section would be 40 cm (16") of specially-selected, high-density crushed rock. The routing would be completely fenced and fully grade-separated. The articulated electric trainsets, similar to the electric TGV developed in France, feature full centralized traffic control with in-cab signalling, and an operating crew of two -- one engineman and one conductor per consist. Ten per cent of the coach fleet would be first-class, with all other seats at a 36 inch pitch.[21] Airline-style food and beverage service would be provided. Cabin crews will vary with the consist make-up, but costs have been based on two stewards per first-class coach and one steward for each pair of economy coaches.

Infrastructure for the EISR would be similar, although a slighly shallower ballast section (35 cm - 14") would be used. Locomotive-hauled LRC-type coaches (minus the tilting mechanism) would make up the operating consists.

Table 8 summarizes unescalated HSR capital and operating costs for the demand levels illustrated in Figure 9, while Table 9 presents a similar summary for EISR.

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20 The "degree of curvature" expression used on railways is the number of degrees of central angle subtended by a chord of 100 feet. If the central angle is one degree, the radius of the curve is approximately 5,730 feet (5,729.65). Up to 8 degrees,

$$\text{radius} = \frac{5{,}730}{\text{degree}}$$

is reasonably accurate and universally used. 0°35' is therefore a curve of 9,823 feet radius.

21 Normal economy seat pitch (distance back to back) on the 115 seat DC9 is 32" and on the 47 seat intercity bus about 33".

TABLE 7

CHARACTERISTICS OF ELECTRIFIED PASSENGER RAIL SYSTEMS
SERVING A TORONTO-KINGSTON-OTTAWA-MIRABEL-MONTREAL ROUTING

	High-Speed Railway		Electrified Intermediate-Speed Railway	
Scenarios	Optimistic Status Quo		Pessimistic	
Route Length	604 km		601 km	
Maximum Operating Speed	260 km/h (160 mph)		190 km/h (118 mph)	
Equipment Type	Articulated electrified trainsets (similar to electrified TGV ordered by SNCF) in mix of 1-5-1 and 1-10-1 consists		Electrified locomotive-hauled consists with LRC-type (but non-tilting) coaches; consist will vary from 1-6 to 1-16-1	
Track Configuration	Full double track on dedicated right-of-way; 57 kg CWR on 2.5 m concrete ties with Pandrol clips; minimum ballast section 40 cm (16"); fully grade-separated		Full double track on new and shared existing rights-of-way; 57 kg CWR on 2.5 m concrete ties with Pandrol clips; minimum ballast section 35 cm (14"); partial grade separation	
Trip Times	Toronto-Kingston	1 hr, 07 min	Toronto-Kingston	1 hr, 27 min
	Toronto-Ottawa	1 hr, 46 min	Toronto-Ottawa	2 hr, 21 min
	Toronto-Mirabel	2 hr, 19 min	Toronto-Mirabel	3 hr, 09 min
	Toronto-Montreal	2 hr, 44 min*	Toronto-Montreal	3 hr, 32 min*
	Kingston-Ottawa	38 min	Kingston, Ottawa	53 min
	Kingston-Mirabel	1 hr, 14 min	Kingston-Mirabel	1 hr, 40 min
	Kingston-Montreal	1 hr, 36 min	Kingston-Montreal	2 hr, 05 min
	Ottawa-Mirabel	34 min	Ottawa-Mirabel	45 min
	Ottawa-Montreal	55 min	Ottawa-Montreal	1 hr, 09 min
	Mirabel-Montreal	18 min	Mirabel-Montreal	22 min
Stations	Toronto	Union Station	Toronto	Union Station
	Kingston	near Elginburg	Kingston	existing
	Ottawa	existing	Ottawa	existing
	Mirabel	Ste.Scholastique	Mirabel	Ste.Scholastique
	Montreal	Central Station	Montreal	Central Station

* The HSR and EISR would provide non-stop Toronto-Montreal service in 2 hr, 19 min. and 3 hr, 20 min. respectively.

TABLE 8

HIGH-SPEED RAILWAY CAPITAL AND OPERATING COSTS, STATUS QUO SCENARIO
($1978 millions)

Initial Capital Costs

Year	Land	Civil Construction	Power System	Signals & Communica-tions	Stations & Buildings	Rolling Stock and Motive Power	Engineering	Contingency	Total
1980	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1981	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	10.00
1982	16.11	1.88	0.00	0.00	0.00	12.24	22.39	8.00	60.63
1983	16.11	116.86	0.00	0.00	0.00	0.00	17.78	21.00	171.74
1984	8.05	135.36	25.76	0.00	3.82	0.00	9.08	23.44	205.51
1985	0.00	211.32	64.39	51.83	16.65	94.41	23.03	52.58	514.20
1986	0.00	123.88	38.63	51.83	20.00	225.54	24.14	48.41	532.44
Total	40.26	589.30	128.78	103.65	40.47	332.19	106.43	153.44	1,494.52

Ongoing Capital and Operating Costs

Year	Labour	Electricity	Material	Other	Total Operating	Civil Contruc-tion	Rolling Stock & Motive Power
1986	31.08	3.74	17.19	1.71	85.84	0.00	0.00
1987	48.63	5.89	26.60	2.36	83.48	0.00	0.00
1988	50.64	6.18	27.42	4.33	88.57	0.00	94.71
1989	52.64	6.47	28.23	4.33	91.68	0.00	0.00
1990	54.65	6.76	29.05	4.33	94.79	0.00	1.34
1991	56.08	6.97	29.62	4.54	97.22	0.00	0.00
1992	57.52	7.19	30.19	4.33	99.23	0.00	0.00
1993	58.95	7.41	30.76	4.33	101.46	0.00	70.07
1994	60.39	7.63	31.33	4.33	103.68	0.00	0.00
1995	61.82	7.85	31.91	5.05	106.63	3.13	1.46
1996	62.77	7.91	32.28	5.36	108.32	0.00	0.00
1997	63.72	7.98	32.66	7.90	112.26	0.00	0.00
1998	64.68	8.04	33.04	7.90	113.65	0.00	56.81
1999	65.63	8.11	33.41	7.90	115.04	0.00	0.00
2000	66.58	8.17	33.79	5.26	113.81	0.00	4.18
2001	67.55	8.44	34.15	5.05	115.20	0.00	0.00
2002	68.53	8.71	34.51	5.05	116.80	0.00	0.00
2003	69.50	8.98	34.87	5.05	118.40	0.00	48.01
2004	70.47	9.24	35.23	5.26	120.21	0.00	0.00
2005	71.44	9.51	35.58	6.46	123.00	0.00	1.46
2006	72.21	9.56	35.90	6.46	124.13	0.00	0.00
2007	72.98	9.60	36.21	6.46	125.26	0.00	0.00
2008	73.75	9.65	36.52	6.67	126.59	0.00	68.41
2009	74.52	9.69	36.83	7.93	128.98	0.00	0.00
2010	75.29	9.74	37.15	7.93	130.11	0.00	1.55
2011	76.01	9.78	37.41	7.93	131.14	0.00	0.00
2012	76.74	9.82	37.67	6.46	130.69	0.00	0.00
2013	77.46	9.86	37.94	6.46	131.72	0.00	48.80
2014	78.19	9.90	38.20	6.67	132.95	0.00	0.00
2015	78.91	9.94	38.46	6.46	133.77	0.00	4.28

TABLE 9

ELECTRIFIED INTERMEDIATE-SPEED RAILWAY CAPITAL AND OPERATING COSTS, PESSIMISTIC SCENARIO ($1978 millions)

Initial Capital Costs

Year	Land	Civil Construction	Power Systems	Signals	Shops & Stations	Vehicles	Planning & Engineering	Contingency	Total
1979	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00	0.00	0.00	7.50	0.00	7.50
1981	0.81	1.26	0.00	0.00	0.00	11.88	17.60	3.69	35.24
1982	0.81	50.75	0.00	0.00	0.00	0.00	12.08	6.25	69.89
1983	0.00	104.03	26.85	0.00	3.72	0.00	7.07	16.91	158.58
1984	0.00	208.36	67.12	37.43	16.21	78.99	21.43	51.42	480.96
1985	0.00	176.19	40.27	37.43	19.31	189.41	24.29	52.03	538.92
Total	1.63	540.59	134.24	74.86	39.24	280.28	89.96	130.30	1,291.09

Annual Operating and Ongoing Capital Costs

Year	Labour	Electricity	Materials	Other	Total Operating	Civil Construction	Vehicles
1986	29.89	3.27	15.16	1.69	79.84	0.00	0.00
1987	46.44	5.31	23.45	2.32	77.52	0.00	0.00
1988	48.03	5.72	24.16	2.24	80.16	0.00	75.00
1989	49.63	6.13	24.86	2.24	82.87	0.00	0.00
1990	51.23	6.54	25.57	3.88	87.22	0.00	1.34
1991	52.32	6.75	26.22	3.88	89.17	0.00	0.00
1992	53.42	6.96	26.86	3.88	91.13	0.00	0.00
1993	54.51	7.18	27.51	4.54	93.74	0.00	63.51
1994	55.61	7.39	28.16	4.33	95.49	0.00	0.00
1995	56.70	7.61	28.81	4.33	97.45	1.72	1.46
1996	57.75	7.72	28.99	4.33	98.79	0.00	0.00
1997	58.80	7.83	29.17	7.86	103.66	0.00	0.00
1998	59.85	7.94	29.36	8.23	105.38	0.00	42.26
1999	60.90	8.05	29.54	8.07	106.56	0.00	0.00
2000	61.96	8.16	29.72	2.28	102.12	3.38	4.18
2001	63.28	8.46	30.08	4.33	106.14	0.00	0.00
2002	64.60	8.75	30.43	4.33	108.10	0.00	0.00
2003	65.92	9.04	30.78	4.33	110.06	0.00	47.62
2004	67.24	9.33	31.13	4.54	112.24	0.00	0.00
2005	68.56	9.62	31.48	4.33	113.99	0.00	1.46
2006	69.23	9.78	31.80	4.33	115.14	0.00	0.00
2007	69.90	9.93	32.12	4.33	116.29	0.00	0.00
2008	70.58	10.09	32.44	4.33	117.43	0.00	50.75
2009	71.25	10.24	32.76	8.07	122.32	0.00	0.00
2010	71.93	10.39	33.08	7.86	123.25	0.00	1.55
2011	72.74	10.54	33.35	7.90	124.52	0.00	0.00
2012	73.54	10.69	33.62	5.05	122.91	0.00	0.00
2013	74.35	10.84	33.89	5.26	124.35	0.00	40.18
2014	75.16	10.98	34.17	5.05	125.37	0.00	0.00
2015	75.97	11.13	34.44	5.05	126.59	0.00	4.28

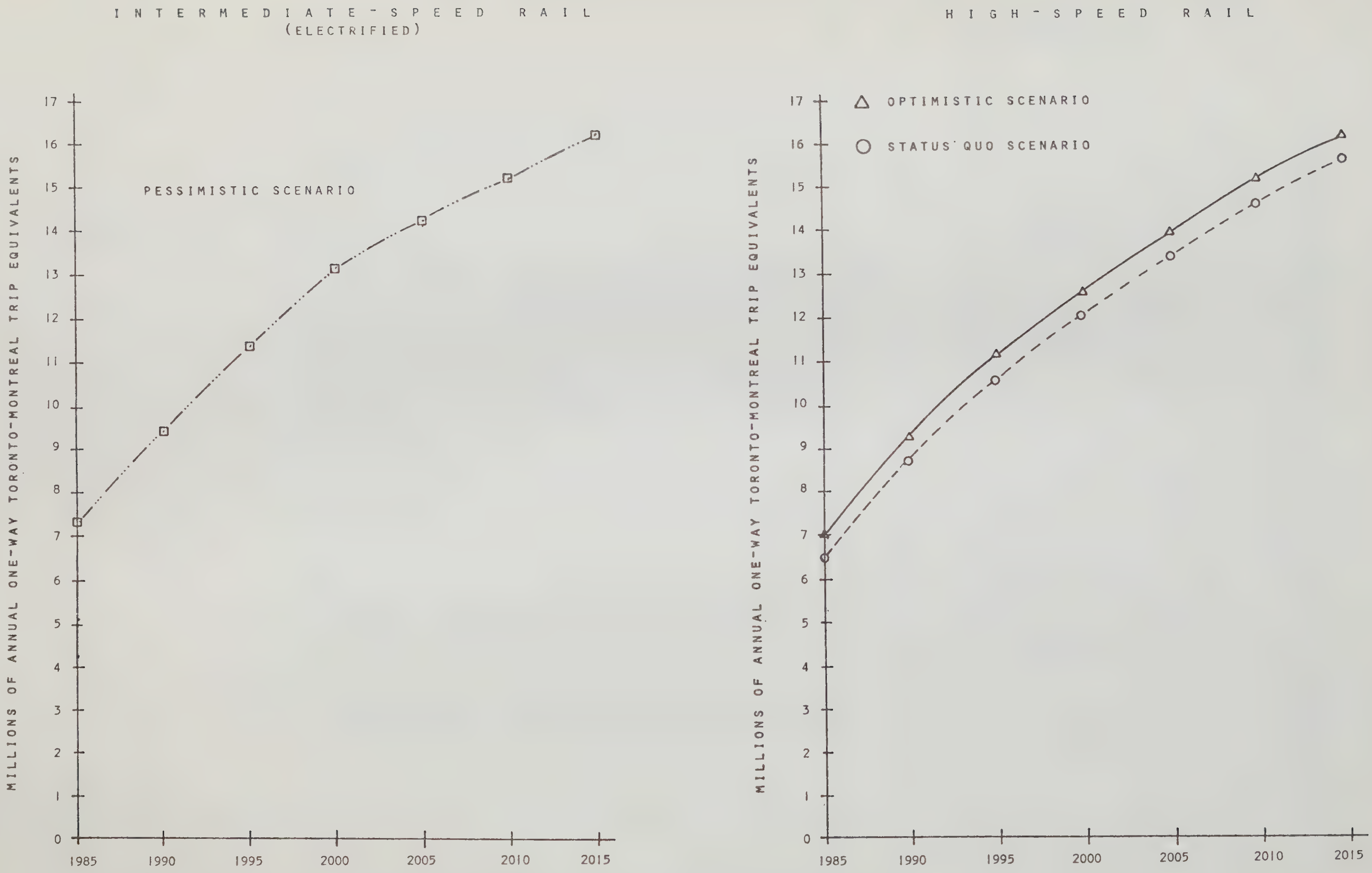

Figure 9 Design levels of passenger demand for electrified rail systems -- weighted aggregate, all origins and destinations

As discussed in Section 3, the MRAIL discounted cash flow methodology was employed to generate financially feasible schedules of system cash flows (presuming the system was operated as an independent solvent entity), unit cost per weighted passenger mile, and unit origin and destination ticket costs. Consistent with the study perspective, it was assumed that the operator of a high-speed passenger system would be quasi-governmental or government-backed. Late 1979 market rates of 15 per cent for equity and 11.5 per cent for debt, selected as being appropriate and consistent with the 9 per cent general inflation rate, were applied to an assumed 50 per cent debt financing repaid in equal instalments over the system life.

Cash flow output for HSR under status quo conditions is shown in Table 10, with unit ticket costs for EISR under the pessimistic scenario in Table 11.

4.2 UNIT COSTS

The cost categories of interest for an evaluation of railway electrification include new substation and catenary installations, modifications to signals and communications, alterations to bridges and other structures to provide adequate clearance, new locomotives, and locomotive-related operating costs. Each of these cost categories will vary significantly with the particular railway line being evaluated.

4.2.1 Power Distribution Systems

The direct capital costs of electrification include: a connecting transmission line to the utility's electric distribution system, a transformer substation, including catenary section and parallel switching station, the overhead catenary for train power, and the electric locomotives. The first two costs vary widely, depending on convenience to and within the power grid, but a premium must be paid in the more remote areas of Northern Ontario. Not only are longer runs of high-voltage transmission lines required, the utility system impedance levels are too high in these areas to permit simple single-phase power connections.[22] This means an extra conductor for the transmission line, three-phase breakers and extra insulators on the high-voltage side of the substation and expensive Scott-connected transformers. The three-phase utility transmission line is estimated to cost $66,000/km in Northern Ontario, while the two-phase single circuit line required in other areas is estimated to cost $50,000/km for construction on railway right-of-way and $125,000/km for new access.

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22 NEMA Standard MG1-14.34 recommends a limit of one per cent phase unbalance to electric motors. The allowable single-phase load can be estimated as one per cent of the three-phase fault input available from the utility. This limits substation loads to less than 10 MVA for much of Northern Ontario, but allows over 40 MVA in the Toronto and Kingston areas.

TABLE 10

DCF CASH FLOW REPORT - HIGH-SPEED RAILWAY, STATUS QUO SCENARIO

ESCALATION: 0.090 EQUITY CHARGE: 0.150 INTEREST RATE: 0.115 TAX RATE: 0.000 D:E RATIO: 1.0
COSTS ESCALATED FROM 1978 LEVELS: ALL CASH FLOWS GIVEN IN LEGAL DOLLARS MILLIONS

YEAR	GROSS REVENUE	OPERATIONS COST	DEBT CHANGES	TOTAL DEBT	INTEREST	CAPITAL INVESTED	CCA TAX SAVINGS	COST INDEX	EQUITY FLOW	UNIT COST	COST $1978
1979	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.090	0.000	0.000	0.000
1980	0.00	0.00	6.00	6.00	0.00	12.00	0.00	1.188	-5.999	0.000	0.000
1981	0.00	0.00	40.20	46.20	0.69	79.72	0.00	1.295	-40.205	0.000	0.000
1982	0.00	0.00	122.98	169.18	5.31	240.64	0.00	1.412	-122.975	0.000	0.000
1983	0.00	0.00	164.70	333.88	19.46	309.95	0.00	1.539	-164.705	0.000	0.000
1984	0.00	0.00	437.20	771.08	38.40	835.99	0.00	1.677	-437.195	0.000	0.000
1985	0.00	0.00	518.72	1289.80	88.67	948.77	0.00	1.828	-518.723	0.000	0.000
1986	167.07	111.14	-42.99	1246.81	148.33	0.00	0.00	1.993	-135.386	72.358	36.314
1987	460.97	189.18	-42.99	1203.82	143.38	0.00	0.00	2.172	85.408	94.518	43.519
1988	505.40	219.59	-42.99	1160.82	138.44	224.21	0.00	2.367	-119.834	98.137	41.454
1989	551.64	248.93	-42.99	1117.83	133.49	0.00	0.00	2.580	126.221	101.405	39.298
1990	604.75	281.87	-42.99	1074.84	128.55	3.75	0.00	2.813	147.583	105.228	37.412
1991	659.79	316.53	-42.99	1031.84	123.61	0.00	0.00	3.066	176.658	110.425	36.018
1992	720.80	353.81	-42.99	988.85	118.66	0.00	0.00	3.342	205.334	116.015	34.717
1993	790.55	396.09	-42.99	945.85	113.72	255.23	0.00	3.642	-17.477	122.376	33.597
1994	869.42	443.18	-42.99	902.86	108.77	0.00	0.00	3.970	274.480	129.417	32.596
1995	961.59	498.75	-42.99	859.87	103.83	19.66	0.00	4.328	296.364	137.645	31.806
1996	1053.67	554.51	-42.99	816.87	98.88	0.00	0.00	4.717	357.283	147.119	31.188
1997	1168.02	627.80	-42.99	773.88	93.94	0.00	0.00	5.142	403.290	159.088	30.941
1998	1282.19	695.62	-42.99	730.89	89.00	318.39	0.00	5.604	136.193	170.368	30.399
1999	1409.56	770.62	-42.99	687.89	84.05	0.00	0.00	6.109	511.897	182.680	29.904
2000	1533.82	836.01	-42.99	644.90	79.11	27.87	0.00	6.659	547.844	193.934	29.125
2001	1690.55	926.39	-42.99	601.91	74.16	0.00	0.00	7.258	647.000	208.504	28.728
2002	1866.04	1028.02	-42.99	558.91	69.22	0.00	0.00	7.911	725.803	224.715	28.405
2003	2060.70	1140.56	-42.99	515.92	64.28	413.99	0.00	8.623	398.876	242.521	28.125
2004	2278.32	1267.08	-42.99	472.93	59.33	0.00	0.00	9.399	908.917	262.298	27.906
2005	2529.77	1417.34	-42.99	429.93	54.39	14.91	0.00	10.245	1000.146	285.109	27.829
2006	2789.23	1564.76	-42.99	386.94	49.44	0.00	0.00	11.167	1132.035	307.998	27.581
2007	3075.85	1727.30	-42.99	343.95	44.50	0.00	0.00	12.172	1261.055	333.028	27.360
2008	3395.09	1909.25	-42.99	300.95	39.55	907.64	0.00	13.268	495.652	360.681	27.185
2009	3762.74	2125.26	-42.99	257.96	34.61	0.00	0.00	14.462	1559.881	392.525	27.142
2010	4149.82	2344.79	-42.99	214.97	29.67	24.51	0.00	15.763	1707.859	425.361	26.984
2011	4574.66	2584.84	-42.99	171.97	24.72	0.00	0.00	17.182	1922.111	461.063	26.834
2012	5015.09	2821.58	-42.99	128.98	19.78	0.00	0.00	18.728	2130.744	497.332	26.555
2013	5528.16	3110.04	-42.99	85.99	14.83	996.20	0.00	20.414	1364.092	539.701	26.438
2014	6097.75	3432.35	-42.99	42.99	9.89	0.00	0.00	22.251	2612.522	586.435	26.355
2015	6715.14	3777.37	-42.99	0.00	4.94	103.93	0.00	24.254	2785.911	636.506	26.244

OPERATING COSTS ARE INCLUDED ANNUALLY IN UNIT COST

CONSTANT DOLLAR UNIT COST = 34.2493

TICKET COSTS DEFLATED TO 1978 AT 0.090 ESCALATION, 0.150 EQUITY AND 0.115 DEBT

	TNTO KGTN	TNTO OTTA	TNTO MRBL	TNTO MTRL	KGTN OTTA	KGTN MRBL	KGTN MTRL	OTTA MRBL	OTTA MTRL	MRBL MTRL
CONST $	10.51	15.65	20.24	21.99	6.78	11.44	13.19	6.37	8.12	3.46
1986	11.15	16.60	21.46	23.31	7.19	12.13	13.98	6.75	8.61	3.67
1987	13.36	19.89	25.72	27.94	8.62	14.54	16.75	8.09	10.31	4.40
1988	12.73	18.94	24.50	26.61	8.21	13.85	15.96	7.71	9.82	4.19
1989	12.06	17.96	23.22	25.23	7.78	13.13	15.13	7.31	9.31	3.97
1990	11.49	17.10	22.11	24.02	7.41	12.50	14.40	6.96	8.87	3.78
1991	11.06	16.46	21.29	23.12	7.13	12.03	13.87	6.70	8.54	3.64
1992	10.66	15.87	20.52	22.29	6.87	11.60	13.37	6.46	8.23	3.51
1993	10.31	15.35	19.86	21.57	6.65	11.22	12.93	6.25	7.96	3.39
1994	10.01	14.90	19.26	20.93	6.45	10.89	12.55	6.06	7.73	3.29
1995	9.76	14.54	18.80	20.42	6.30	10.62	12.25	5.92	7.54	3.21
1996	9.57	14.25	18.43	20.02	6.18	10.42	12.01	5.80	7.39	3.15
1997	9.50	14.14	18.29	19.86	6.13	10.33	11.91	5.76	7.33	3.13
1998	9.33	13.89	17.97	19.52	6.02	10.15	11.70	5.65	7.20	3.07
1999	9.18	13.67	17.67	19.20	5.92	9.99	11.51	5.56	7.09	3.02
2000	8.94	13.31	17.21	18.70	5.77	9.73	11.21	5.42	6.90	2.94
2001	8.82	13.13	16.98	18.44	5.69	9.60	11.06	5.34	6.81	2.90
2002	8.72	12.98	16.79	18.24	5.62	9.49	10.94	5.28	6.73	2.87
2003	8.63	12.85	16.62	18.06	5.57	9.39	10.83	5.23	6.67	2.84
2004	8.57	12.75	16.49	17.92	5.53	9.32	10.74	5.19	6.61	2.82
2005	8.54	12.72	16.45	17.87	5.51	9.29	10.71	5.18	6.60	2.81
2006	8.47	12.60	16.30	17.71	5.46	9.21	10.62	5.13	6.54	2.79
2007	8.40	12.50	16.17	17.56	5.42	9.14	10.53	5.09	6.48	2.76
2008	8.35	12.42	16.07	17.45	5.38	9.08	10.47	5.06	6.44	2.75
2009	8.33	12.40	16.04	17.43	5.37	9.07	10.45	5.05	6.43	2.74
2010	8.28	12.33	15.95	17.32	5.34	9.01	10.39	5.02	6.40	2.73
2011	8.24	12.26	15.86	17.23	5.31	8.96	10.33	4.99	6.36	2.71
2012	8.15	12.14	15.69	17.05	5.26	8.87	10.22	4.94	6.29	2.68
2013	8.12	12.08	15.62	16.97	5.23	8.83	10.18	4.92	6.27	2.67
2014	8.09	12.04	15.58	16.92	5.22	8.80	10.15	4.90	6.25	2.66
2015	8.06	11.99	15.51	16.85	5.20	8.77	10.10	4.88	6.22	2.65

TABLE 11

TICKET COST ($1978)
ELECTRIFIED INTERMEDIATE-SPEED RAILWAY, PESSIMISTIC SCENARIO

TICKET COSTS DEFLATED TO 1978 AT 0.090 ESCALATION, 0.150 EQUITY AND 0.115 DEBT

	TNTO KGTN	TNTO OTTA	TNTO MRBL	TNTO MTRL	KGTN OTTA	KGTN MRBL	KGTN MTRL	OTTA MRBL	OTTA MTRL	MRBL MTRL
CONST $	7.78	11.58	14.97	16.26	5.02	8.46	9.75	4.71	6.00	2.56
1986	8.57	12.76	16.50	17.93	5.53	9.33	10.75	5.19	6.62	2.82
1987	10.01	14.90	19.27	20.93	6.45	10.89	12.55	6.06	7.73	3.29
1988	9.43	14.04	18.15	19.72	6.08	10.26	11.82	5.71	7.28	3.10
1989	8.92	13.28	17.18	18.66	5.76	9.71	11.19	5.41	6.89	2.94
1990	8.56	12.74	16.47	17.89	5.52	9.31	10.73	5.18	6.61	2.81
1991	8.21	12.22	15.81	17.17	5.30	8.93	10.30	4.97	6.34	2.70
1992	7.90	11.76	15.21	16.53	5.10	8.60	9.91	4.79	6.10	2.60
1993	7.65	11.39	14.73	16.01	4.94	8.33	9.60	4.64	5.91	2.52
1994	7.40	11.01	14.24	15.47	4.77	8.05	9.28	4.48	5.71	2.43
1995	7.17	10.68	13.81	15.00	4.63	7.80	9.00	4.35	5.54	2.36
1996	7.01	10.43	13.49	14.66	4.52	7.63	8.79	4.25	5.41	2.31
1997	6.99	10.40	13.45	14.61	4.51	7.60	8.76	4.23	5.39	2.30
1998	6.86	10.21	13.21	14.35	4.43	7.46	8.60	4.16	5.30	2.26
1999	6.73	10.02	12.95	14.07	4.34	7.32	8.44	4.08	5.19	2.21
2000	6.42	9.55	12.35	13.42	4.14	6.98	8.05	3.89	4.95	2.11
2001	6.40	9.53	12.33	13.39	4.13	6.97	8.03	3.88	4.94	2.11
2002	6.33	9.43	12.19	13.25	4.09	6.89	7.94	3.84	4.89	2.08
2003	6.27	9.34	12.08	13.12	4.05	6.82	7.87	3.80	4.84	2.06
2004	6.23	9.27	11.99	13.02	4.02	6.77	7.81	3.77	4.81	2.05
2005	6.18	9.19	11.89	12.91	3.98	6.72	7.74	3.74	4.77	2.03
2006	6.11	9.09	11.76	12.77	3.94	6.65	7.66	3.70	4.72	2.01
2007	6.05	9.00	11.64	12.65	3.90	6.58	7.58	3.66	4.67	1.99
2008	5.99	8.92	11.54	12.53	3.87	6.52	7.52	3.63	4.63	1.97
2009	6.05	9.01	11.65	12.65	3.90	6.58	7.59	3.67	4.67	1.99
2010	6.00	8.93	11.55	12.54	3.87	6.53	7.52	3.63	4.63	1.97
2011	5.96	8.87	11.47	12.46	3.84	6.48	7.47	3.61	4.60	1.96
2012	5.85	8.71	11.26	12.23	3.77	6.36	7.33	3.54	4.51	1.92
2013	5.82	8.67	11.21	12.18	3.76	6.34	7.30	3.53	4.50	1.92
2014	5.79	8.62	11.15	12.11	3.73	6.30	7.26	3.51	4.47	1.91
2015	5.77	8.58	11.10	12.06	3.72	6.27	7.23	3.49	4.45	1.90

The cost of a basic substation (including civil construction, switch gear and insulators for one transformer) is estimated to be $900,000. The incremental cost of switch gear and insulators for a two-transformer, double track substation is $260,000, and the cost of a single-phase transformer is estimated at $400,000 for a 40 MVA unit and $500,000 for two 20 MVA units. The cost of switching stations at phase break locations is estimated at $200,000 on double track and $110,000 on single track. Parallel connecting stations are estimated to cost $140,000 each and isolating switches $40,000 each. The cost of central supervisory control of all powered switch gear and the monitoring of substation loads is estimated to cost $750,000 for a double track substation and $550,000 for a single track substation.

The total estimated cost of a single track 40 MVA substation and a double track 80 MVA substation are $2.2 million and $3.5 million respectively. The incremental costs associated with Scott-connected transformers[23] are assumed to be

23 To overcome power phase difficulties.

$250,000 for a single track substation and $500,00 for a double track substation.

The comparative catenary costs for the four lines will vary less significantly. The lower power requirements of the GO trains can be accommodated by a lower supply voltage (25 kV) rather than by reducing catenary capacity. Catenary costs for the other lines (on which 50 kV is desirable) would be about 7 per cent higher because of higher insulation requirements. Additionally, the high-speed passenger line requires a compound or stitched catenary rather than the simple catenary adequate for the other applications. This involves a 30 per cent cost premium. All applications require automatic tensioning.

Through sharp curves, shorter mast spacings are necessary to limit the lateral displacement of the catenary from track centre line. This generally results in about 30 per cent higher costs than on straight track. The higher cost would apply mostly to the Northern Ontario lines, where about 30 per cent of the route length is curved.

Most intercity routes on the other hand can tolerate a longer average mast spacing on tangent track than can the GO lines, since fewer crossovers and overhead structures will be encountered. In recognition of these variables, a 63 metre mast spacing on tangent track has been assumed for cost estimates for all intercity trackage.

Labour efficiency during catenary construction on single track lines would be lower than on double track due to more interruptions for passage of trains. On the new passenger system, there would, of course, be very little train operation during construction. In recognition of these circumstances, it is assumed that on-track labour (estimated at 25 per cent of total cost) will work at 80 per cent efficiency on double track lines and at 60 per cent efficiency on single track lines.

The cost of cantilever pole foundations used by Electrack is significantly higher than one would predict by escalating unit costs which were reported in other electrification studies in the early 1970's. While the present study did not allow sufficient time to investigate the accuracy of these estimates, a mid-point cost of $1,000 per cantilever pole foundation was used in our study rather than the $1,800 estimated by Electrack.

4.2.2 Locomotives

Locomotive costs are based on $2,010,000 for a 6,000 hp, six-axle North American freight locomotive, and $1 million for a 4,000 hp European commuter locomo-

tive.[24] It will be assumed that a four-axle freight locomotive (4,000 hp) costs $1,600,000. The characteristics of electric locomotives compared to diesel-electrics are such that for freight service in most of Ontario it has been estimated that electric locomotives at 1,000 hp/axle will replace diesel-electric locomotives on a horsepower basis for express trains, but on an adhesion basis for lower priority trains. These lower priority trains may achieve a reduced travel time at a higher energy intensity under electric operation. While the improved equipment utilization would most likely outweigh the marginally greater energy and track maintenance costs, this evaluation is beyond the scope of the present study.

The reduced maintenance requirement of the electric locomotive results in about a 12 per cent improvement in availability. Four-axle and six-axle electric locomotives will be used, allowing 4, 6, 8, 10 and 12 thousand gross horsepower consists. These will be assumed to replace four- and six-axle diesel electric units at an average 3,300 horsepower per unit. The net replacement ratio on a horsepower basis is then one electric for 1.12 x 5 ÷ 3.3 or 1.7 diesel-electrics. Electric locomotives are estimated to have a 10 per cent adhesion advantage over diesel-electrics, which means that the net replacement ratio on an adhesion basis is one electric for 1.12 x 1.1 or 1.23 diesel-electrics. Useful lives of both locomotive types will be taken as 30 years, with diesel-electrics receiving higher maintenance resources.

The Hawker-Siddeley bi-level car used by GO Transit offers an excellent opportunity for multiple power unit (MU) operation. While these cars may now be purchased as self-propelled units, the high weight-and-volume-to-power ratios of diesel engines requires each car to have its own power unit. Electric operation would permit cars with only two axles powered to operate as a five-car set, with back-to-back ten-car sets possible in peak periods. This would result in much better power utilization than would result from a single 3,000 hp locomotive and the modular design of the Hawker-Siddeley car should permit a substantial cost saving. One could replace two 2,400 hp diesel locomotives with two electric power modules and two powered bogies. The diesel units are estimated to cost $750,000 each, the complete electric module, with bogies, $500,000 (one half the cost of a complete 4,000 hp electric locomotive).

4.2.3 Indirect Capital Costs

The indirect capital costs of electrification include civil reconstruction to attain the necessary catenary-ground clearances, the modification of track circuits (for signal operation) to be compatible with traction currents and the

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24 The former is a quote from General Electric for an updated model E60C and the latter is a recent price paid for an ASEA locomotive delivered to Korea.

protection of communication and signal lines (and other wayside conductors) from electromagnetic interference.

Civil reconstruction is not an important part of the dedicated passenger system since most of it would be new construction and the maximum vehicle height is about three to five feet lower than that of a freight vehicle. In the GO service application, civil reconstruction has been kept to a minimum level by using a 25 kV feed voltage, and could be eliminated if freight traffic on the line were restricted to lower load gauge traffic only. Restricting clearances for 50 kV on the freight lines have been identified but cannot be costed with any degree of confidence in this type of study. Consequently, the costs in this category are quite tentative.

Members of CIGGT have examined some Ontario track with a view to identification of bridge, tunnel and cut clearance restrictions, most of which was not directed towards the height appropriate for 50 kV and 25 kV electrification of freight trackage. In fact, lateral clearance of the installation of additional trackage was the dominant consideration (catenary for a dedicated passenger system could be lower, and hence clearance would not pose a problem). One point was clear, estimates or assumptions without field reconnaissance are perilous. Such reconnaissance is not expensive, but it is beyond the scope of the present study.

Similarly, only average costs can be derived for signal and communication modifications. The total cost per track-kilometre is estimated to be $31,000 for single track, $25,000 for double track signalled for single direction running only, and $40,000 for double-running, double track.

The cost of electromagnetic compatibility may be increased further if non-railway telephone or sensitive communication devices exist near the rail line. If mitigation at the source via booster transformers or autotransformers is desirable, then substation costs would be tripled or quadrupled. This requirement is a possibility in the urban areas of Southern Ontario but will be excluded from the present analysis.

4.2.4 Relevant Operating Costs

4.2.4.1 Maintenance Costs

Locomotive maintenance costs will be based on estimates of the 1975 CIGGT study, escalated at ten per cent a year to 1980. The costs per locomotive-kilometre thus become $0.868 for diesel-electric and $0.579 for electrics. Catenary and substation maintenance will also be based on that study and escalated at the same rate, becoming $2,500 per route-kilometre for single track. Labour

economies of scale will exist for double track and the relevant cost will be estimated as $4,400 per route-kilometre on double track.

4.2.4.2 Energy Consumption and Cost

Fuel consumption figures are not available on a line-by-line basis, and hence, the analysis required estimation of the energy consumption. The average train speed was identified, on a segment by segment basis, where possible, and train resistance was established, using the CN formula, for this speed. From this, the level track energy consumption was computed.

The effect of rising grade was considered next. Since track profiles were not readily available, the cumulated track rise in each direction was derived from 1:50,000 scale maps. This track rise was then converted to an annual energy consumption for the annual traffic figures. Finally, the energy consumed to overcome mandatory train stops (for passengers or for change of train crew) was evaluated. The energy estimate was taken as the sum of the three values. A comparison of the energy estimate with figures developed for the CN electrification study for the Toronto-Montreal route revealed that our estimate was slightly higher, on a per unit basis, possibly because of an increase in train speeds since 1965. Conversion constants were derived from the energy consumption estimates for the two sites, and applied to all other lines considered.

The derived energy consumption figures were those delivered at the rail. Locomotive units do not operate at their maximum efficiency point for much of the time. Hence, conversion figures of 0.50 lbs of fuel per brake horsepower hour, and 75 per cent efficiency, were selected for the diesel-electric unit and the electric unit, respectively. After the energy requirements were converted to gallons of fuel, or kilowatt-hours of electric energy, as appropriate, adjustments were made for idling and supply losses. The diesel units consume some fuel while idling, at stops, fuelling stations, and during equipment changes. This extra consumption, along with spillage and loss at the fuelling stations, amounts to roughly five per cent of the fuel consumed. This was added to the fuel consumption figure (it closely matches the figure used by CN in their electrification study of 1965).

The power supply losses in the catenary and its transformers was taken as 10 per cent of the energy delivered to the locomotives. This was added to the electric consumption figures.

The diesel fuel savings were based on the world price of crude oil, adjusted for refining losses and cost. The 31¢/litre in 1980, more than double the current subsidized price, excludes provincial taxes that presumably would also be charged on electricity. (Actually the implicit assumption is that the province

would tax the trains at the same rate, regardless of energy consumption.) The use of the cost of imported oil is important, not only because of the dramatic effect this has on the financial viability of electrification (discussed in the succeeding section), but because it represents the national economic cost, or at least one dimension of it.[25] Fuel saved by electrification (or any other economy), anywhere in the country, is effectively imports saved, and hence the import cost is relevant.[26] The railway companies, faced only with subsidized prices (estimated at 45 per cent of world price), would see it quite differently.

The cost of electricity is essentially the sum of the relevant energy charge (¢/kWh) and demand change ($/kW of peak monthly demand). The 3.64¢/kWh used is an analogum of rates quoted by Ontario Hydro for another CIGGT study, using a representative average load factor.

4.2.5 Financial Parameters

The engineering economy evaluation is based on the generally prevailing inflation rate of 9 per cent, with after-tax equity and long-term debt costs of 15 and 11.5 per cent[27] respectively, which are generally consistent with 9 per cent inflation. Sixty per cent equity is combined with 40 per cent debt to parallel the CP Ltd capital structure, and the long-term corporate tax rate was assumed to be 52 per cent. Capital cost allowances were taken as in Table 12, but capital cost allowances (CCA) are essentially an investment incentive mechanism, and electrification assets could be included in more attractive categories -- say the 40 per cent on aircraft or the 30 per cent allowable on highway trucks. The CCA mechanism is further discussed later in this report.

Differential cost escalation rates (net of inflation) used were then computed for the "status quo" economic scenario of the high-speed passenger study:

Labour	1.0
Petroleum Fuel	3.0
Land	1.5
Civil Construction	-0.5
Vehicles, Trains and Aircraft	0.0
Electricity	1.0
Engineering	0.5
Aluminum Products	1.5
Electronics	-1.0
Stations	0.0
Maintenance Materials	-0.5

25 The balance of payments impact may be more important than the public cash flow aspect.

26 The relevant economic cost is really the cost of risk-free imported oil, the best available proxy for which is Norwiegen North Sea oil landed in Germany. Such a price would be appreciably higher than Canada's presumed least risky (and most expensive) contract supply from South America.

27 The economic evaluation indicates that, within a broad range, interest rate has little influence.

Recent information -- a Stanford Research Institute study brought to our attention by Canadian National -- forecasts that by the year 2000 electricity prices will decrease to 83 per cent of 1980 levels (in real terms). This amounts to an average of almost -1 per cent, or "net of inflation," without the differential decay described in Section 2. Although this rate would enhance the benefits from electrification substantially (over those calculated in the +1 per cent decayed), it was not used in the present study, for the set of unit rates are a balance of causality interrelationships, and all would have required recalculation.

TABLE 12

CAPITAL COST ALLOWANCE WRITE-OFF RATES

Asset Class	Assumed CCA Rate	Notes*
Locomotives	10%	CCA Class 6
Railway Track Structure	4%	CCA Class 1
Power Distribution Systems	6%	An interpretation of CCA Class 6
Signals	30%	CCA Class 10 which includes signal and control systems which are primarily electronic (as opposed to current railway systems)
Maintenance Facilities	20%	CCA Class 8
Planning, Design and Engineering	100%	

* CCA Classes refer to the allowances in Schedule B of the Income Tax Act. A 1979 consolidation of the Act was used.

4.3 CP THUNDER BAY TO WINNIPEG

The costs of conversion to electrification of, and annual cost savings for, the 420 mile double track CP Thunder Bay to Winnipeg route have been estimated on the basis of an estimated 1980 traffic level of 44 million gross tons. This figure has been derived from the most conservative traffic forecasts made for that link in the 1976 CIGGT Electrification Study. For evaluation purposes, traffic growth has been assumed to be three per cent annually with moderate growth rate decay. These parameters imply a 50 per cent increase to 66 MMGT by the year 2002, but do not project an increase beyond 80 MMGT throughout the next century.

The capital and annual operating costs and savings, as developed for the segment, for 1980 traffic levels, at 1980 price levels, are summarized in Table 13.

The basic technical life of locomotives has been estimated to be thirty years. This, however, presents some practical difficulties. Diesel locomotive power plants tend to be refurbished during the life of the locomotive. Thus, diesel locomotives have been entered into the economic evaluation model as two portions, half being the basic frame with a thirty-year life and ten per cent salvage value, and half being the power plant with a fifteen-year life and no salvage value. To represent the longer life of straight electric locomotives, a 15 per cent salvage value has been postulated. Diesel locomotive savings have been assumed to be 100 per cent variable with traffic volume, while electric locomotive purchases are 98 per cent variable with traffic. The difference is due to the increased utilization -- or decreased inefficiency (290,000 hp of diesels are assumed replaced by 320,000 hp) of electrics -- that can be gained with a larger electric locomotive fleet.[28]

The bulk of the capital costs of conversion are for the purchase and installation of catenary, power feed lines and substations. These are long-lived assets with high salvage values, since complete replacement is not necessary. For this already double-tracked line, low volume factors (2.5 to 5 per cent) have been used with these asset classes to represent the essentially fixed nature of these costs.

Capital costs also include estimates for signal system modifications, shop modifications and reconstruction of overhead clearances (where required). These are <u>one time only</u> modifications required before electrified operations can take place, so that no replacement or expansion with volume is required. A planning allowance of six per cent of initial capital costs and an engineering allowance of seven per cent of initial capital costs have been included.

For the economic evaluation, conversion was assumed to take place over five years, with planning costs being incurred mainly in the first and second years. Construction costs are assumed spread evenly over the four years before electrified operations commence, while locomotive costs were drawn down over the final two years.

For the operating costs and cost savings for the CP Thunder Bay to Winnipeg link, volume factors for diesel fuel and electrical energy are 100 per cent, reflecting a one-for-one increase in the long-term (unescalated) total cost of these cost components with traffic. Locomotive maintenance has a 90 per cent

28 Were the whole network to be converted to electrified operations, this utilization improvement would eventually disappear.

TABLE 13

CP WINNIPEG TO THUNDER BAY - ESTIMATED ELECTRIFCATION COSTS
($1980 for 1980 traffic volumes)

ESTIMATED 1980 OPERATING COSTS

		($ thousands)
SAVINGS:		
Diesel Fuel (consumption from sample TPC runs, diesel fuel based on world price*)	115.7 million L @ 31¢/L	$ 35,903
Diesel Maintenance (escalated from 1975 CIGGT study)	15.1 million unit km @ $0.868	13,200
Track Maintenance (reduced locomotive tonnage and escalated 1975 CIGGT unit costs)	270 million GTM @ $1,360	367
		$ 49,470
COSTS:		
Electricity (from sample TPC runs and 30 per cent load factor)	424 million kWh @ 3.64¢	$ 14,445
Electric Maintenance (escalated from 1975 CIGGT study)	12.46 million unit km @ $0.579	7,214
Substation and Catenary Maintenance (escalated from 1975 CIGGT study)	677 km @ $4,400	2,980
		$ 24,639
	ANNUAL NET TOTAL	$ 24,831

INITIAL CAPITAL COSTS

		($ thousands)
SAVINGS:		
Diesel Locomotives (average 3,300 hp)	88 @ $980,000	$ 86,240
COSTS:		
Electric Locomotives	32 of 4,000 hp @ $1,600,000 32 of 6,000 hp @ $2,010,000	$115,520
Catenary	1,477 km @ $100,000/km	147,700
Substations	11 @ $4,000	44,000
Signalling Modifications	1,352 km @ $25,000/km	33,800
Modify Locomotive Repair Facilities	1 @ $1,000,000 (estimate)	1,000
Civil Reconstruction	escalated from 1975 CIGGT study	14,100
Planning and Engineering	7 per cent of fixed equipment	16,840
Construction Supervision	6 per cent of fixed equipment	14,440
Utility Feed Line	3 @ 45 km, 8 @ 10 km 215 km @ $66,000/km	14,190
Construction Depots		2,000
Rail Mounted Equipment†		1,280
		$404,870
	NET TOTAL CAPITAL	$318,630

* a subsidized price of 65 per cent of world levels was also used
† after construction, these would be used for catenary maintenance

volume factor to reflect the time-related, as opposed to purely wear-related, components of maintenance. A ten per cent volume factor has been used for catenary maintenance, since this item is almost exclusively time-related.

The summary cash flows for the CP Thunder Bay to Winnipeg link (deflated to 1980 price levels) are presented in Table 14 for a 1986 conversion to electrified operations. Initial capital expenditures can be seen before 1986, with a small amount of sustaining capital thereafter. The most important figure is the fifth column which gives net annual operating savings. These increase steadily with traffic growth and real fuel and labour price escalation. The final column gives the accumulated incremental present value of cost savings (IPV) at the end of each year. It becomes increasingly negative until 1986 with the conversion investment, but increases steadily as net annual operating cost savings are accumulated. Somewhere between the years 1997 and 1998 IPV becomes positive, indicating that the present value of cost savings, at world oil prices, have more than matched the present value of the accumulated conversion capital cost, for the base case interest rate of 11.5 per cent and equity return rate of 15 per cent. On this basis, the capitalized payback period (CPP) is thirteen years of electrified operations. After the year 1998, cost savings continue to grow, and IPV increases annually.

Both IPV (assuming an infinite life) and CPP, using a range of interest rates, equity rates and assumed conversion delays, are presented in Table 15. In general, the IPV decreases with delay in conversion, since there are savings to be gained now. The CPP, however, decreases with delay, since the savings during early operating years are higher due to traffic growth and real fuel price escalation. For example, with the base case financing rates of 11.5 per cent and 15 per cent for equity, delay in the start of conversion from 1981 to 1991 reduces IPV by 16 per cent from $321.5 million to $271.6 million. More importantly, however, the capitalized payback period is reduced from thirteen years to eight years.

The rate of return on equity capital has an important impact on the financial attractiveness of electrification of this segment. A three per cent increase in this parameter to 18 per cent increases the CPP for a 1981 conversion from thirteen to sixteen years, while cutting the IPV to 30 per cent of its original value. A three per cent decrease in equity return rate decreases the CPP by only two years, but increases IPV almost fourfold.

Interest rate variations in the absence of any changes in other financial parameters have little impact, a change of 1.5 per cent in this parameter resulting in a less than two per cent change in IPV and almost no change in the CPP. This low sensitivity to interest rates illustrates that the bulk of the savings in this example accrue solely from the substitution of electricity for diesel fuel.

TABLE 14

CASH FLOWS, ELECTRIFICATION OF CP THUNDER BAY-WINNIPEG
(status quo escalation, world oil prices)

Year	Traffic (millions) (of gross) (tons)	Net Incremental Capital Invested ($ millions) (1980)	Net Incremental Debt Service Costs ($ millions) (1980)	Net Incremental Tax and Operating Cost Savings ($ millions) (1980)	Net Incremental Cash Flow* ($ millions) (1980)	Incremental Present Value at Year End ($ millions)
1981	45.3	9.22	0.00	4.79	(.74)	(.70)
1982	46.6	66.88	.39	5.91	(34.61)	(31.79)
1983	47.9	62.47	3.18	8.94	(31.72)	(58.80)
1984	49.1	78.25	5.55	1.93	(50.57)	(99.61)
1985	50.3	73.29	8.40	6.13	(46.24)	(134.99)
1986	51.5	.77	12.26	30.21	17.49	(122.31)
1987	52.6	.74	11.12	28.93	17.37	(110.37)
1988	53.8	.72	10.09	28.11	17.59	(98.92)
1989	54.8	.70	9.15	27.62	18.05	(87.77)
1990	55.9	.68	8.31	27.40	18.69	(76.84)
1991	56.9	.65	7.54	27.38	19.45	(66.05)
1992	57.9	.63	6.84	27.53	20.31	(55.37)
1993	58.8	.61	6.21	27.81	21.23	(44.79)
1994	59.8	.59	5.64	28.20	22.21	(34.30)
1995	60.7	.57	5.12	28.69	23.23	(23.91)
1996	61.5	.55	4.65	29.25	24.27	(13.61)
1997	62.3	.53	4.22	29.88	25.34	(3.42)
1998	63.1	.51	3.84	30.57	26.43	6.66
1999	63.9	(22.66)	3.49	19.27	29.38	17.27
2000	64.7	(22.68)	1.63	19.54	31.52	28.07
2001	65.4	(.58)	.28	31.42	31.49	38.28
2002	66.1	(.57)	.26	32.38	32.46	48.27
2003	66.7	(.56)	.23	33.35	33.45	58.03
2004	67.3	(.54)	.21	34.34	34.46	67.55
2005	67.9	(.53)	.19	35.34	35.47	76.84

* including debt issue not otherwise shown in this table

TABLE 15

CP THUNDER BAY TO WINNIPEG
INCREMENTAL PRESENT VALUE ($ MILLIONS) OF ELECTRIFICATION CONVERSION
CAPITALIZED PAYBACK PERIODS SHOWN IN BRACKETS

Changeover Initiated	11.5% Interest Rate			13.0% Interest Rate			10.0% Interest Rate		
	Equity Rate			Equity Rate			Equity Rate		
	15.0%	18.0%	12.0%	15.0%	18.0%	12.0%	15.0%	18.0%	12.0%
1981	$321.5 (13)	$ 99.8 (16)	$1299.8 (11)	$317.3 (13)	$ 96.5 (17)	$1224.0 (11)	$325.7 (12)	$103.1 (16)	$1235.6 (10)
1986	300.5 (10)	96.3 (12)	1198.1 (8)	297.4 (10)	94.1 (13)	1193.2 (9)	303.7 (10)	98.4 (12)	1203.1 (8)
1991	271.6 (8)	84.5 (9)	1152.7 (7)	269.2 (8)	83.1 (10)	1148.5 (7)	273.9 (8)	85.9 (9)	1156.9 (7)

This saving grows over time and is predicated on two major premises -- the acceptance of world oil prices in Canada, and real price escalation of three per cent (decayed) over and above the general inflation rate. These two parameters contribute the most to the base case CPP of thirteen years and IPV of $321 million. These base case levels, however, are not what CP Rail would face in electrifying its Thunder Bay to Winnipeg link, since oil prices currently paid are much lower than world price.

While savings that accrue to the nation as a whole should be based on world prices, from a corporate point of view a significantly lower price would be a more realistic forecast. Although the railways currently pay about 45 per cent of the world market oil price,[29] financial sensitivity calculations were made using 65 per cent of world price levels. In such a situation, the annual cost savings are greatly reduced. As a result, the payback period for the base case is increased to twenty-five years, and the IPV is decreased to $117.8 million.[30]

In addition to uncertainty about the relationship between the Canadian and world diesel fuel prices, uncertainty also surrounds the rate of increase in world

29 At this rate, and using the other costs and parameter values of this study, electrification of Winnipeg to Thunder Bay would not be financially viable.

30 With 65 per cent of world price, there is a slight advantage to a five-year delay in conversion while the absolute magnitude of diesel fuel savings increase. During that time, the CPP would drop to nineteen years and the IPV increase to $124 million.

price. Forecasts inevitably have it increasing more rapidly than inflation, but the range is indeed broad. As well as the three per cent real increase (before decay), the CP Thunder Bay to Winnipeg link was also run assuming a one per cent differential (at world prices) for fuel. At this rate, net savings (IPV) were cut by more than 60 per cent and the CPP lengthened to eighteen years (for an immediate initiation of electrification). This (differential rate) sensitivity, although significant, does not materially offset the viability of the conversion in question.

4.4 CP TO TIDEWATER

The Canadian Pacific direct connection between Montreal and Thunder Bay via Ottawa and northern Ontario is 863 miles. This is 165 miles shorter than the route from Montreal through Toronto and joining the northern Ontario route at Sudbury (Romford). The line is comprised of three distinct segments:

> Montreal to Smiths Falls, 128 miles, double track main line carrying about 25 million gross tons, over half of this being Montreal-Toronto traffic.
>
> Smiths Falls to Sudbury, 311 miles, single track secondary line carrying about 10 million gross tons.
>
> Sudbury to Thunder Bay, 522 miles, single track main line carrying about 20 million gross tons.

The electrification costs and cost savings for these three sections at current traffic levels are summarized in Tables 16, 17 and 18. Higher unit costs for catenary have been used west of Smiths Falls because of the increased construction difficulty posed by the terrain through the Canadian shield.

Because the 128 mile double track section at the Montreal end of this route is shared, evaluation of the financial impact of electrification is difficult. At one extreme, only the Montreal to Western Canada link might be electrified over this section. At the other extreme, the CP Montreal to Toronto main line might be electrified, with the Montreal to Western Canada traffic being carried incrementally.

On an overall basis, with the Montreal-Smiths Falls section electrified only for Western Canadian traffic, the direct Montreal to Thunder Bay CP route would require an initial investment on the order of $485 million, giving an IPV of $163 million, and a CPP of twenty-six years. The best portion of the route is the Thunder Bay to Sudbury section, which, by itself, generates an IPV of $161 million and a CPP of eighteen years. The financial viability of converting the full line is, however, affected by a long CPP on the low density Smiths Falls to Sudbury section and a net loss created on the double track section into

TABLE 16

CP SMITHS FALLS TO MONTREAL - ESTIMATED ELECTRIFCATION COSTS
($1980 for 1980 traffic volumes)*

ESTIMATED 1980 OPERATING COSTS

		($ thousands)
SAVINGS:		
Diesel Fuel (consumption from sample TPC runs, diesel fuel based on world price)	22.5 million @ 31¢/L	$ 6,975
Diesel Maintenance (escalated from 1975 CIGGT study)	267 million unit km @ $0.868	2,319
Track Maintenance (reduced locomotive tonnage and escalated 1975 CIGGT unit costs)	56 million GTM @ $1,360	76
		$ 9,370
COSTS:		
Electricity (from sample TPC runs and 30 per cent load factor)	80 million kWh @ 3.64¢	$ 2,912
Electric Maintenance (escalated from 1975 CIGGT study)	2.12 million unit km @ $0.579	1,228
Substation and Catenary Maintenance (escalated from 1975 CIGGT study)	200 km @ $4,400	880
		$ 5,020
	ANNUAL NET TOTAL	$ 4,350

INITIAL CAPITAL COSTS

		($ thousands)
SAVINGS:		
Diesel Locomotives (average 3,300 hp)	15 @ $980,000	$ 14,700
COSTS:		
Electric Locomotives	6 of 4,000 hp @ $1,600,000 6 of 6,000 hp @ $2,010,000	21,660
Catenary	450 km @ $97,250	43,760
Substations	2 @ $3,500,000	10,500
Signalling Modifications	400 km @ $25,000	10,000
Modify Locomotive Repair Facilities	1 @ $1,000,000 (estimate)	1,000
Civil Reconstruction	estimated	6,000
Planning and Engineering	7 per cent of fixed equipment	4,990
Construction Supervision	6 per cent of fixed equipment	4,280
Utility Feed Line	45 km @ $66,000	2,970
Construction Depots		2,000
Rail Mounted Equipment		1,280
		$108,440
	NET TOTAL CAPITAL	$ 93,740

* based on all traffic over this segment except Montreal commuter trains

TABLE 17

CP SMITHS FALLS TO SUBBURY - ESTIMATED ELECTRIFCATION COSTS
($1980 for 1980 traffic volumes)

ESTIMATED 1980 OPERATING COSTS

		($ thousands)
SAVINGS:		
Diesel Fuel (consumption from sample TPC runs, diesel fuel based on world price)	22.6 million L @ 31¢/L	$ 7,010
Diesel Maintenance (escalated from 1975 CIGGT study)	2.8 million unit km @ $0.868	2,420
Track Maintenance (reduced locomotive tonnage and escalated 1975 CIGGT unit costs)	77 million GTM @ $1,360	105
		$ 9,535
COSTS:		
Electricity (from sample TPC runs and 30 per cent load factor)	80.57 million kWh @ $3.64¢	$ 2,930
Electric Maintenance (escalated from 1975 CIGGT study)	2.33 million unit km @ $0.579	1,350
Substation and Catenary Maintenance (escalated from 1975 CIGGT study)	503 km @ $2,500	1,260
		$ 5,540
	ANNUAL NET TOTAL	$ 3,995

INITIAL CAPITAL COSTS

		($ thousands)
SAVINGS:		
Diesel Locomotives (average 3,300 hp)	15 @ $980,000	$ 14,700
COSTS:		
Electric Locomotives	6 of 4,000 hp @ $1,600,000 5 of 6,000 hp @ $2,010,000	19,650
Catenary	600 km @ $107,000/km	64,200
Substations	8 @ $2.25 million	18,000
Signalling Modifications	503 km @ $31,000	15,600
Civil Reconstruction	escalated from 1975 CIGGT study	10,000
Planning and Engineering	7 per cent of fixed equipment	7,550
Construction Supervision	6 per cent of fixed equipment	6,470
Utility Feed Line	60 km @ $66,000/km	3,960
Construction Depots		2,000
Rail Mounted Equipment		1,280
		$148,710
	NET TOTAL CAPITAL	$134,010

TABLE 18

CP SUDBURY TO THUNDER BAY - ESTIMATED ELECTRIFCATION COSTS
($1980 for 1980 traffic volumes)

ESTIMTED 1980 OPERATING COSTS

		($ thousands)
SAVINGS:		
Diesel Fuel (consumption from sample TPC runs, diesel fuel based on world price)	80 million L @ $31¢/L	$ 24,800
Diesel Maintenance (escalated from 1975 CIGGT study)	10.36 million unit km @ $0.868	8,990
Track Maintenance (reduced locomotive tonnage and escalated 1975 CIGGT unit costs)	185 million GTM @ $1,360	250
		$ 34,040
COSTS:		
Electricity (from sample TPC runs and 30 per cent load factor)	285 million kWh @ 3.64¢	$ 10,370
Electric Maintenance (escalated from 1975 CIGGT study)	8.55 million unit km @ $0.579	4,950
Substation and Catenary Maintenance (escalated from 1975 CIGGT study)	890 km @ $2,500	2,230
		$ 17,550
	ANNUAL NET TOTAL	$ 16,490

INITIAL CAPITAL COSTS

		($ thousands)
SAVINGS:		
Diesel Locomotives (average 3,300 hp)	42 @ $980,000	$ 41,160
COSTS:		
Electric Locomotives	15 of 4,000 hp @ $1,600,000 15 pf 6,000 hp @ $2,010,000	54,150
Catenary	1,050 km @ $110,000	115,500
Substations	12 @ $2,500, 2 @ $2,250	34,500
Signalling Modifications	890 km @ $31,000/km	27,590
Modify Locomotive Repair Facilities	1 @ $1,000,000 (estimate)	1,000
Civil Reconstruction	escalated from 1975 CIGGT study	20,000
Planning and Engineering	7 per cent of fixed equipment	13,900
Construction Supervision	6 per cent of fixed equipment	11,920
Utility Feed Line	270 km @ $66,000/km	17,820
Construction Depots		2,000
Rail Mounted Equipment		1,280
		$299,660
	NET TOTAL CAPITAL	$258,500

Montreal. Were this section already electrified, the overall CPP for the route is decreased to sixteen years, with an IPV on the order of $200 million.

Traffic growth projections for this route are quite modest, with traffic growing to one-and-a-half times the current loadings over the next forty-five years. The financial results could be improved were there a substantial attraction of new traffic to this line. One suggestion that has been made is the direct railway shipment of grain and other bulk commodities from Western Canada to Atlantic ports.[31] Under such a scheme, up to 20 million additional tons could be added to the Montreal to Thunder Bay link. Some upgrading and capacity expansion would have to take place before such additional traffic could be handled effectively. Neither the costs of upgrading nor the costs of shipping to tidewater can be addressed in this study.

If, say, 10 million gross tons were added to the existing traffic between Montreal and Thunder Bay, the added annual cost savings would advance the capitalized payback period to fourteen years with an IPV of $530 million.[32] A strong warning is required here; these figures assume the Thunder Bay to Montreal movement is already economic. The above figures must not be interpreted as any reflection on the overall economics of the movement.

4.5 CN MONTREAL TO WINNIPEG (VIA OTTAWA)

Canadian National's direct connection between Montreal and Western Canada is similar to CP's. There is a 382 mile, single track line with low traffic density from Capreol, joining the Montreal-Toronto main line at Coteau (38 miles west of Montreal). Rather than going west to Thunder Bay, CN's line goes directly to Winnipeg, with about 20 million tons of electrifiable traffic.

Initial capital costs of the conversion from Coteau to Winnipeg (summarized in Tables 19 and 20) are $624 million. At current traffic volumes, the CPP would be twenty years with an IPV of $291 million.

As with Canadian Pacific, the potential for additional tonnage on this line is good. Evaluation of an additional ten million tons of traffic to tidewater, as done with CP, indicates that the CPP would be reduced to fourteen years and IPV could be increased to $564 million. Again, the costs of additional capacity are not included.

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31 See "St. Lawrence Viability in Terms of Grain Movement: Implications for Public Policy," a paper delivered by Alan J. Carsen and Om P. Tangri to the June 1980 meetings of the Canadian Transportation Research Forum.

32 Higher volume factors have been used for catenary to allow for the increased sidings and partial double tracking that would be needed with this extra traffic.

TABLE 19

CN COTEAU TO CAPREOL - ESTIMATED ELECTRIFCATION COSTS
($1980 for 1980 traffic volumes)

ESTIMATED 1980 OPERATING COSTS		($ thousands)
SAVINGS:		
Diesel Fuel (consumption from sample TPC runs, diesel fuel based on world price)	23.9 million @ $31¢/L	$ 7,410
Diesel Maintenance (escalated from 1975 CIGGT study)	3.4 million unit km @ $0.868	2,970
Track Maintenance (reduced locomotive tonnage and escalated 1975 CIGGT unit costs)	41 million GTM @ $1,360	56
		$ 10,436
COSTS:		
Electricity (from sample TPC runs and 30 per cent load factor)	86.3 million kWh @ 3.64¢	$ 3,140
Electric Maintenance (escalated from 1975 CIGGT study)	3 million unit km @ $0.579	1,740
Substation and Catenary Maintenance (escalated from 1975 CIGGT study)	616 km @ $2,500	1,540
		$ 6,420
	ANNUAL NET TOTAL	$ 4,016

INITIAL CAPITAL COSTS		($ thousands)
SAVINGS:		
Diesel Locomotives (average 3,300 hp)	20 @ $980,000	$ 19,600
COSTS:		
Electric Locomotives	7 of 4,000 hp @ $1,600,000 8 of 6,000 hp @ $2,010,000	27,280
Catenary	726 km @ $100,000	72,600
Substations	10 @ $2,250,000	22,500
Signalling Modifications	616 km @ $31,000/km	19,100
Civil Reconstruction	assumed	10,000
Planning and Engineering	7 per cent of fixed equipment	8,690
Construction Supervision	6 per cent of fixed equipment	7,450
Utility Feed Line	100 km @ $66,000/km	6,600
Construction Depots		2,000
		$176,220
	NET TOTAL CAPITAL	$156,620

TABLE 20

CN CAPREOL TO WINNIPEG - ESTIMATED ELECTRIFCATION COSTS
($1980 for 1980 traffic volumes)

ESTIMATED 1980 OPERATING COSTS

		($ thousands)
SAVINGS:		
Diesel Fuel (consumption from sample TPC runs, diesel fuel based on world price)	148 million @ 31¢/L	$ 45,880
Diesel Maintenance (escalated from 1975 CIGGT study)	25.77 million unit km @ $0.868	22,368
Track Maintenance (reduced locomotive tonnage and escalated 1975 CIGGT unit costs)	460 million GTM @ $1,360	626
		$ 68,874
COSTS:		
Electricity (from sample TPC runs and 30 per cent load factor)	535 million kWh @ 3.64¢	$ 19,474
Electric Maintenance (escalated from 1975 CIGGT study)	21.27 million unit km @ $0.579	12,315
Substation and Catenary Maintenance (escalated from 1975 CIGGT study)	1,502 km @ 2,500	3,755
		$ 35,544
	ANNUAL NET TOTAL	$ 33,330

INITIAL CAPITAL COSTS

		($ thousands)
SAVINGS:		
Diesel Locomotives (average 3,300 hp)	136 @ $980,000	$133,280
COSTS:		
Electric Locomotives	49 of 4,000 hp @ $1,600,000 50 of 6,000 hp @ $2,010,000	$178,900
Catenary	1,772 km @ $110,000	194,920
Substations	24 @ $2,500,000	60,000
Signalling Modifications	1,502 km @ $31,000	46,562
Modify Locomotive Repair Facilities	1 @ $1,000,000 (estimate)	1,000
Civil Reconstruction	estimated	15,000
Planning and Engineering	7 per cent of fixed equipment	18,024
Construction Supervision	6 per cent of fixed equipment	15,449
Utility Feed Line	1,000 km @ $66,000	66,000
Construction Depots		4,000
Rail Mounted Equipment		1,280
		$601,135
	NET TOTAL CAPITAL	$467,855

A reasonable enrichment to CN's direct Montreal to Winnipeg route is the single track main line from Toronto to Capreol. This line currently carries about 15 million tons of through traffic, one third of which is express. Conversion investment expenditures and operating cost savings are summarized in Table 21. For this line, the CPP is twenty-three years with an IPV of $43 million.

CN's lines into Thunder Bay have not been examined in detail. East of Thunder Bay, there are two links to the main line which currently handle 3.5 and 5 million tons per year. Capital costs of catenary far outweigh the operating cost savings for these lines. The 432 mile link between Thunder Bay and Winnipeg through Atikokan and Fort Frances has sufficient traffic to be financially attractive and would have a CPP under twenty years with current traffic. Electrification of the additional 16 million tons that use part of this line from Winnipeg, crossing the United States border near Fort Frances for shipment to Duluth, would enhance the financial attractiveness. Of course, any shift in bulk traffic from Thunder Bay to Atlantic port destinations would have an adverse effect on this line.

4.6 CN MONTREAL TO TORONTO

The costs of conversion and first year cost savings for the CN Montreal-Toronto double track main line are summarized in Table 22. Current through traffic levels average 37 million gross tons, of which about 13 per cent each are express freight and passenger. Costs and savings have not been considered for the Montreal-Ottawa freight traffic which uses the eastern 40 miles of this route or the GO traffic which uses the western segment of the line. Rather, low traffic growth, the recent experience of both CN and CP on this run, has been used for the evaluation.

Lower capital costs per track-kilometre of catenary have been used since the line is double tracked, and construction is fairly straightforward. Additional power feeds have been allowed for in the Kingston to Brockville area at $100,000 per kilometre. Since the line is already double-tracked with good siding capacity, low volume factors have been used for fixed plant expansion. In Toronto, catenary has been allowed to serve both the MacMillan Yard and the downtown freight terminals. This adds about 30 route miles to the "nominal" Toronto-Montreal distance.

Net capital costs of conversion are $286 million (in 1980 price levels), with a capitalized payback of sixteen years. The IPV is relatively low -- $168 million -- compared to some of the other mainline operations evaluated. This lower magnitude is a function of the low traffic growth rate used in the evaluation.

TABLE 21

CN TORONTO TO CAPREOL - ESTIMATED ELECTRIFCATION COSTS
($1980 for 1980 traffic volumes)

ESTIMATED 1980 OPERATING COSTS

		($ thousands)
SAVINGS:		
Diesel Fuel (consumption from sample TPC runs, diesel fuel based on world price)	26.2 million @ $31¢/L	$ 8,122
Diesel Maintenance (escalated from 1975 CIGGT study)	3.64 million unit km @ $0.868	3,160
Track Maintenance (reduced locomotive tonnage and escalated 1975 CIGGT unit costs)	79 million GTM @ $1,360	107
		$ 11,389
COSTS:		
Electricity (from sample TPC runs and 30 per cent load factor)	92.5 million kWh @ 3.64¢	$ 3,367
Electric Maintenance (escalated from 1975 CIGGT study)	2.87 million unit km @ $0.579	1,662
Substation and Catenary Maintenance (escalated from 1975 CIGGT study)	490 km @ $2,500	1,225
		$ 6,254
	ANNUAL NET TOTAL	$ 5,135

INITIAL CAPITAL COSTS

		($ thousands)
SAVINGS:		
Diesel Locomotives (average 3,300 hp)	23 @ $980,000	$ 22,540
COSTS:		
Electric Locomotives	8 of 4,000 hp @ $1,600,000 9 of 6,000 hp @ $2,010,000	$ 30,890
Catenary	490 km @ $107,000	52,430
Substations	6 @ $2,250,000	13,500
Signalling Modifications	430 km @ $31,000	13,330
Modify Locomotive Repair Facilities	1 @ $1,000,000 (estimate)	1,000
Civil Reconstruction	estimated	5,000
Planning and Engineering	7 per cent of fixed equipment	5,023
Construction Supervision	6 per cent of fixed equipment	4,306
Utility Feed Line	6 10 km lengths @ $66,000	3,960
Construction Depots		2,000
Rail Mounted Equipment		1,280
		$132,719
	NET TOTAL CAPITAL	$110,179

TABLE 22

CN MONTREAL TO TORONTO - ESTIMATED ELECTRIFCATION COSTS
($1980 for 1980 traffic volumes)

ESTIMATED 1980 OPERATING COSTS

		($ thousands)
SAVINGS:		
Diesel Fuel (consumption from sample TPC runs, diesel fuel based on world price)	78 million L @ 31¢/L	$ 24,180
Diesel Maintenance (escalated from 1975 CIGGT study)	16.68 million unit km @ $0.868	14,480
Track Maintenance (reduced locomotive tonnage and escalated 1975 CIGGT unit costs)	410 million GTM @ $1,360	560
		$ 39,220
COSTS:		
Electricity (from sample TPC runs and 30 per cent load factor)	278 million kWh @ 3.64¢	$ 10,120
Electric Maintenance (escalated from 1975 CIGGT study)	12.66 million unit km @ $0.579	7,330
Substation and Catenary Maintenance (escalated from 1975 CIGGT study)	539 km @ $4,400	2,372
		$ 19,822
	ANNUAL NET TOTAL	$ 19,398

INITIAL CAPITAL COSTS

		($ thousands)
SAVINGS:		
Diesel Locomotives (average 3,300 hp)	51 @ $980,000	$ 49,980
COSTS:		
Electric Locomotives	17 of 4,000 hp @ $1,600,000 17 of 6,000 hp @ $2,010,000	61,370
Catenary	1,275 km @ $97,250/km	124,000
Substations	9 @ $3,500	31,500
Signalling Modifications	1,352 km @ $25,000/km	43,120
Modify Locomotive Repair Facilities	2 @ $1,000,000 (estimate)	2,000
Civil Reconstruction	assumed	30,000
Planning and Engineering	7 per cent of fixed equipment	16,143
Construction Supervision	6 per cent of fixed equipment	13,837
Utility Feed Line	45 km @ $125,000 + 100 km @ $50,000	10,625
Construction Depots		2,000
Rail Mounted Equipment		1,280
		$335,875
	NET TOTAL CAPITAL	$285,895

If one of the new dedicated passenger systems is constructed in the Toronto-Ottawa-Montreal corridor, most of the five million annual tons of passenger traffic on the CN Lakeshore line will be diverted. Infrastructure capital costs for conversion of the line would not be substantially reduced by removal of the passenger traffic, since the only savings are a few miles of catenary near the Montreal and Toronto passenger terminals and a few passing sidings. Annual net costs savings (at 1980 price levels for 1980 traffic volumes) are lowered from \$19.4 million to \$14.77 million.[33]

At the lowered traffic volumes, the electrification capitalized payback period is increased from sixteen to twenty years and the IPV lowered by \$54 million.

The low growth traffic experience being projected into the future may be overly conservative. The Montreal-Toronto corridor is characterized by a high degree of road competition. With electrification and increasing fuel prices, the express traffic growth and diversion potential for the railway line could be very important. Recomputing the electrification costs and benefits for Montreal to Toronto with a doubling of traffic in thirty years, and without passenger traffic, results in an increase of IPV to \$210 million and a CPP of fifteen years.

One of the extensions to the electrification to the CN Montreal-Toronto link would be the conversion of the double-tracked line west from Toronto to Sarnia, with a few-miles-long branch into the Hamilton yard, and another branch to Windsor. As noted in Section 3, this line has considerable local traffic, and traffic destined for other lines and carriers. Thus, while some sections of this route carry more than 40 million gross tons, electrification conversion costs (see Table 23) have been based on an average route density of only 20 MGT, with low traffic growth.

With a 1981 initiation of electrification, the IPV would be \$28 million with a forty-two year CPP. Delay in conversion to 1991 generates more favourable financial results, with IPV increasing to \$41 million and the CPP being reduced to twenty-three years. There are, however, potential cost savings from converting this line as other lines in southwestern Ontario are electrified, allowing more of the transient traffic (Toronto-Sarnia) to be hauled with electric traction without increases in fixed infrastructure investment.

4.7 GO TRANSIT

Evaluation of electrification of the GO Transit system is complicated by a number of factors. In addition to concerns about the actual construction costs

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33 The proposed Uxbridge and Havelock services have not been considered.

TABLE 23

CN TORONTO TO SARNIA/WINDSOR* - ESTIMATED ELECTRIFCATION COSTS
($1980 for 1980 traffic volumes)

ESTIMATED 1980 OPERATING COSTS		($ thousands)
SAVINGS:		
Diesel Fuel (consumption from sample TPC runs, diesel fuel based on world price)	42 million @ 31¢/L	$ 13,020
Diesel Maintenance (escalated from 1975 CIGGT study)	5.4 million unit km @ $0.868	4,687
Track Maintenance (reduced locomotive tonnage and escalated 1975 CIGGT unit costs)	93 million GTM @ $1,360	126
		$ 17,833
COSTS:		
Electricity (from sample TPC runs and 30 per cent load factor)	150 million kWh @ 3.64¢	$ 5,460
Electric Maintenance (escalated from 1975 CIGGT study)	4.5 million unit km @ $0.579	2,606
Substation and Catenary Maintenance (escalated from 1975 CIGGT study)	525 km @ $4,400	2,310
		$ 10,376
	ANNUAL NET TOTAL	$ 7,457
INITIAL CAPITAL COSTS		($ thousands)
SAVINGS:		
Diesel Locomotives (average 3,300 hp)	31 @ $980,000	$ 30,380
COSTS:		
Electric Locomotives	11 of 4,000 hp @ $1,600,000 12 of 6,000 hp @ $2,010,000	$ 41,720
Catenary	1,083 km @ $97,250	105,322
Substations	8 @ $3,500,000	28,000
Signalling Modifications	1,050 km @ $40,000	42,000
Modify Locomotive Repair Facilities	1 @ $1,000,000 (estimate)	1,000
Civil Reconstruction	estimated	20,000
Planning and Engineering	7 per cent of fixed equipment	11,782
Construction Supervision	6 per cent of fixed equipment	10,099
Utility Feed Line	8 10 km lengths @ $66,000	5,280
Construction Depots		2,000
Rail Mounted Equipment		1,280
		$268,483
	NET TOTAL CAPITAL	$238,103

* including branch into Hamilton yard

for the catenary and the price to be used for diesel fuel, which are common to all links in this report, there are questions of what portion of the GO system to electrify, how this might fit into electrification plans for intercity links, and what future traffic patterns are likely to be.

The most promising option for GO is the electrification of the Lakeshore segment between Oakville and Pickering. This segment has the highest traffic levels per route-mile and track-mile. The much less frequent services to Hamilton, Milton, Georgetown and Richmond Hill (along with proposed services on the Uxbridge and Havelock lines) would remain diesel-powered. This option requires the electrification of 68.5 route-kilometres of double track, plus sidings, yard and terminal trackage. The Electrack Inc. estimates for the GO Lakeshore route included 87 per cent triple track over the whole route, plus 32 km for the Union Station area and 18 km for the Willowbank service facilities. These were based on that study's terms of reference, which included all tracks over which the GO trains might be directed. It is operationally feasible, however, to leave unelectrified (at least) some of the existing fourth and fifth parallel tracks and yard trackage which is only occasionally used. The basic capital cost estimates presented here are based on 50 per cent of the route triple-tracked plus 12 km of terminal trackage.[34]

The costs associated with signalling and communication modifications for a complex double-track line are estimated to be $80,000 per route-kilometre, including engineering and construction supervision. For the 70 km Lakeshore route the cost is thus $5.6 million.

Nineteen electric power cars would be required to meet the existing twenty minute headways, assuming ten bi-level cars per train and a 95 per cent motive power availability. At $500,000 per module, the total cost would be $9.5 million. Ideally, these units could replace twenty-four 2,400 hp diesel-electric locomotives in the same service, but six diesels would need to be retained to meet the needs of the unelectrified segments of the GO network. If a spare is also retained, only 12 of the existing 19 locomotives can be leased or sold. These 12 units are assumed to have a salvage value of $400,000 each, resulting in a net motive power investment of $4.7 million. Future motive power requirements, however, would displace new purchases of diesel-electric locomotives on a 1.12 to 1 basis. The cost of a comparable replacement diesel-electric of 2,400 hp is estimated to be $750,000.

The 1979 diesel fuel consumption by all GO trains has been estimated by GO officials to be about 20 million litres, with the Lakeshore service consuming

34 A sensitivity run has also been made using the Electrack estimates for catenary unit costs and catenary quantities.

18.64 million litres; about 90 per cent of this consumption, or 16.78 million litres, is assumed to be displaced with electrification of the Lakeshore route. With the reduction in the number of vehicles in a ten-coach consist from 12 to 10, the electrified operation will achieve an efficiency advantage. This effect is estimated to reduce the conversion factor of 17.1 kWh per Imperial gallon of diesel fuel, which is frequently applied in equal gross tonnage situations, to 14.96 for this operation.

The motive power maintenance costs have been assumed to be the same as those used in the freight line analysis -- $0.868 per diesel-kilometre and $0.579 per electric-kilometre. The diesel-electric and electric unit-kilometeres are based on an average of 43 one-way trips a day, half of which are made with single locomotive consists and half with two locomotives, yielding 1.65 million power unit-kilometres per year.

Under electrified operation, the revenue from the off-peak lease of locomotives will no longer be available. The loss is estimated to be about 300 unit days at $350 or $105,000 per year.

The Phase I (Lakeshore) GO system costs and costs savings are summarized in Table 24.

The full net conversion capital costs for electrifying the Lakeshore segment are $52.7 million. With the currently projected low traffic growth increases, this investment can be recovered from annual operating costs savings (with a capitalized payback of sixteen years), with the IPV slowly growing to $30 million. The monetary disadvantage to delay is not great. By not beginning electrification until 1986, the IPV drops to only $28.7 million, while three years are cut off the CPP.

Using the higher unit costs and additional miles of catenary developed in the Electrack report, capital costs for the conversion increase by $6.5 million. This increase creates a three-year increase in the CPP to nineteen years and a $3 million decrease in IPV.

Of greater impact is the cost of converting the GO system to electrified operations incrementally with the electrification of the CN Montreal-Toronto main line. In this scenario, only the lines east of Union Station and the dedicated GO sidings and terminal trackage must have catenary added, thereby avoiding about $20 million in initial capital expenditures. Here, the incremental CPP is only ten years and the IPV increases to $37 million. The saving would, of course, be shared by GO and VIA and/or CN.

TABLE 24

GO TRANSIT, PHASE I - ESTIMATED ELECTRIFCATION COSTS
($1980 for 1980 traffic volumes)

ESTIMATED 1980 OPERATING COSTS

		($ thousands)
SAVINGS:		
Diesel Fuel (consumption from sample TPC runs, diesel fuel based on world price)	16.78 million L @ 31¢/L	$ 5,200
Diesel Maintenance (escalated from 1975 CIGGT study)	1.65 million unit km @ $0.868	1,430
Track Maintenance (reduced locomotive tonnage and escalated 1975 CIGGT unit costs)	165 million GTM @ $1,360	224
		$ 6,854
COSTS:		
Lost diesel locomotive rentals	300 days @ $350	$ 105
Electricity (from sample TPC runs and 30 per cent load factor)	55.22 million kWh @ 3.64¢	2,010
Electric Maintenance (escalated from 1975 CIGGT study)	1.65 million unit km @ $0.579	955
Substation and Catenary Maintenance (escalated from 1975 CIGGT study)	70 km @ $4,400	308
		$ 3,378
	ANNUAL NET TOTAL	$ 3,476

INITIAL CAPITAL COSTS

		($ thousands)
SAVINGS:		
Diesel Locomotives (average 3,300 hp)	12 @ $400,000	$ 4,800
COSTS:		
Electric Conversions	19 @ $500,000	9,500
Catenary		25,510*
Substations	from Electrack	2,322
Signalling Modifications	70 km @ $80,000/km	5,600
Modify Locomotive Repair Facilities	1 @ $500,000 (estimate)	500
Civil Reconstruction	from Electrack	5,335
Planning and Engineering	7 per cent of fixed equipment	2,750
Construction Supervision	6 per cent of fixed equipment	2,360
Utility Feed Line	assumed provided	-
Construction Depots		2,000
Rail Mounted Equipment		1,280
CN Support	from Electrack	333
		$ 57,490
	NET TOTAL CAPITAL	$ 52,690

* Electracks figure for catenary is $32.368 million with correspondingly higher planning and supervision allowances.

The financial attractiveness of electrifying the GO Lakeshore route is vulnerable to fuel price assumptions. At 65 per cent of world oil prices, or at a lower real annual increase in prices, the net savings of electrification are reduced to considerably under $10 million (IPV) and the payback period is considerably lengthened. Even with the incremental electrificaton of the Lakeshore route, the payback period would be quite long. For GO, however, the financial results of long payback periods and low IPV's are not as troublesome as they would be for a commercial freight carrier. Where normally one would expect that some of the benefits of reduced variable cost would be transferred from the carriers to shippers, the nature of GO, and the lack of commercial competition, put more control of prices in the hands of the system operator. Thus, it is possible for the cost savings to be retained as compensation for the increased capital burden. In reality, since GO operations are funded with tax dollars, the retention of these cost savings effects an indirect transfer of benefits to the ridership by reducing the demand on the public purse.

The electrification of GO Phase II (the extensions to Hamilton, Milton, Georgetown and Richmond Hill)[35] is not financially attractive at current traffic densities. An additional 313 track kilometres of catenary would be required -- more than on the Lakeshore route -- but average traffic densities at 1980 ridership levels are 10 to 15 per cent of those on the Lakeshore route. The capital costs and annual cost savings for Phase II GO are summarized in Table 25. As can be seen, at 1980 price levels and 1980 traffic, there is <u>no</u> net operating cost saving. Incremental operating costs savings will not outweigh incremental costs until 1987 traffic and price levels are reached.

The DCF cash flow results indicate that the IPV for GO Phase II electrification is negative ($16.5 million with a 1981 start, dropping to $7.3 million with a 1991 start.) This means that the cost of conversion of these lines is greater than the potential savings.

With Phase II, the potential for the electrification of GO service incrementally on top of electrification of the intercity freight lines is great. If the CN lines from Toronto to Sarnia and from Toronto to Northern Ontario were to be converted, the incremental capital costs for Phase II GO would be substantially lowered, such that net savings could be accumulated over the long run.

The traffic growth assumptions have a great impact here. Based on information supplied by the Ministry of Transportation and Communications, low growth rate estimates have been used. For Phase II, the assumed parameters amount to an eighty year period to increase by half of the 1980 levels. With increased fuel prices, there will be increased pressure for commuters to switch from automo-

35 The proposed Uxbridge and Havelock services have not been considered.

TABLE 25

GO TRANSIT, PHASE II - ESTIMATED ELECTRIFCATION COSTS
($1980 for 1980 traffic volumes)

ESTIMATED 1980 OPERATING COSTS		($ thousands)
SAVINGS:		
Diesel Fuel (consumption from sample TPC runs, diesel fuel based on world price)	3.2 million L @ 31¢/L	$ 992
Diesel Maintenance (escalated from 1975 CIGGT study)	0.3 million unit km @ $0.868	260
Track Maintenance (reduced locomotive tonnage and escalated 1975 CIGGT unit costs)	30 million GTM @ $1,360	41
		$ 1,293
COSTS:		
Lost diesel locomotive rentals	300 days @ $350	$ 105
Electricity (from sample TPC runs and 30 per cent load factor)	10.53 million kWh @ 3.64¢	380
Electric Maintenance (escalated from 1975 CIGGT study)	0.3 million unit km " $0.579	174
Substation and Catenary Maintenance (escalated from 1975 CIGGT study)	313 km @ $2,500	782
		$ 1,441
	ANNUAL NET TOTAL	$ (148)
INITIAL CAPITAL COSTS		($ thousands)
SAVINGS:		
Diesel Locomotives	7 @ $400,000, 7 @ $750,000	$ 8,050
COSTS:		
Electric Locomotives	13 @ $500,000	6,500
Catenary	313 km @ $124,000	38,800
Substations	1	2,434
Signalling Modifications	313 km @ $25,000	7,825
Civil Reconstruction	estimated	5,000
Planning and Engineering	7 per cent of fixed equipment	3,780
Construction Supervision	6 per cent of fixed equipment	3,240
Construction Depots		2,000
		$ 69,579
	NET TOTAL CAPITAL	$ 61,529

biles to public transit. A very high growth scenario -- one which produces a threefold increase in forty years with decaying growth thereafter -- would produce much more favourable results. For the Lakeshore route, with a 1981 start, the payback period would be under ten years and the IPV would nearly double. In the Phase II routes, electrification would generate a positive IPV, if conversion is delayed until 1991. The capitalized payback period, however, would still be long.

Taken together, the immediate, or slightly delayed, electrification of the Lakeshore route, followed by the electrification of the Phase II lines, would generate overall net savings, with the operating cost savings from the Lakeshore line being used to finance the conversion of the other lines. If implemented between 1985 and 1995, the overall electrification of GO could generate an IPV of $20 million, with a CPP in the order of twenty-five to thirty years of operations. There may also be some additional savings in operating an all-electric system. Such benefits have not been included here.

5. FINANCING

Railway electrification poses a complicated and formidable financing problem, and while it is not greater than that faced by other industries, particularly frontier petroleum exploration and tar sands development, this problem should not be underrated.

The expected fuel and maintenance cost savings electrification would provide can only be achieved through a substantial increase in the capital intensity of the operations concerned. Railway infrastructure is a very long-term capital investment and must be classified as somewhat risky, particularly with regard to what financiers term political risk. The capital investment is substantial and definite, and the costs savings (years into the future) are subject to the uncertainties of any forecast. The leakage of certain of the benefits of railway electrification to what is defined in Figure 2.1 as the extra-firm environment is unavoidable, and further qualifies anticipated project returns.

The parallel to the oil sands development is relevant here, not only because both provide means to reduce Canadian dependence on imported oil but because of certain project venture similarities. Oil sands development is ahead of electrification chronologically; their development was under study when Canadian railways were still converting from steam to diesel. The first development in the Athabaska tar sands was a prototype or pilot project -- as is recommended for electrification -- and as is forecast for electrification, this prototype lost a lot of money over a substantial period of its early life. Great Canadian Oil Sands was, however, successfully financed, and the funds it initially required were of the same order of magnitude as the cost of electrifying Winnipeg to Thunder Bay.

Another close similarity is the dependence of the economics of each project on forecasts of substantial petroleum price escalation, and both the financial uncertainty and political risk this implies. The spectre of a venture like GCOS (or successors like Syncrude) suffering years of deficits, only to be faced with the confiscation of windfall gains or "excess profits" and unanticipated escalating royalties is very real. The railway electrification situation is a close parallel, with the confiscation of windfall gains and royalties replaced by perpetuation of the non-compensatory Crow's Nest Rate, public service subsidy reductions, etc. The lack of pricing freedom, while of different genesis, is also closely equivalent.

While feasible with perserverance, financing railway electrification will probably be at least as difficult as financing Syncrude. The expenditure would, of course, be an order of magnitude lower, but Syncrude was the second development -- after the technology and profitability had been proven -- and the power

to control pricing was vested exclusively in defined levels of government. The eventual pattern of electrification financing, if it is arranged within the next few years,[36] will probably be similar, with an industry/government (federal and provincial) partnership. Similarly, political and pricing regulation agreements will also be involved. As with frontier petroleum exploration, a special tax concession mechanism would be desirable.

The financial or financing feasibility implied in the subsequent subsectons is conditional on the federal government ceasing to subsidize the consumption of petroleum, or alternatively, providing equal subsidy for non-consumption of petroleum. While a mechanism for the subsidy of non-consumption is clear in the case of railway electrification -- simple payment of the subsidy savings, an estimate of which is provided in Table 26, to the electrifying railway -- other applications are more complicated. It is more difficult (say) to subsidize a householder for not heating his home with oil, or for keeping the temperature low, or for having a small house, or for having no house at all, and so on. The inevitable solution is domestic acceptance of world price, and it will come eventually. In the longer run, it is difficult to imagine how the economy could survive otherwise, but governments are very short-term oriented. Without binding governmental guarantee of world oil prices, or an equivalent non-consumption subsidy, commercial financing of electrification seems impossible. Left alone, electrification will probably await world oil prices.

TABLE 26

ESTIMATED OIL SUBSIDY SAVINGS, ASSUMING DOMESTIC OIL PRICE AT 65 PER CENT OF THE MARGINAL (MOST EXTENSIVE) IMPORTED OIL - ELECTRIFICATION OF CP WINNIPEG TO THUNDER BAY -

1986	$ 26.79 million
1987	$ 30.64 million
1988	$ 35.01 million
1989	$ 39.91 million
.	.
.	.
.	.
2000	$155.47 million

5.1 PROJECT FINANCING

Under a structure as discussed above, or (at a later date) as a strictly commercial venture, electrification will likely be financed as a venture project.

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36 As electrification becomes increasingly attractive over time (see Section 5.2), financing will become easier.

In addressing the general nature of the project financing problem, four aspects must be examined. First, it is necessary to identify potential interested parties. A decision on the type of structure appropriate to manage the project would come next. After that, isolation of the various types of capital investment would produce an approximation of the project debt requirement. Then a project promotion package would be prepared and discussed with prospective guarantors, lenders, and equity partners.

A reasonable estimate of the overall funding requirements is essential, even in the early stages of evaluation. In formulating this estimate, the long-term type of capital commitment and the indefinite nature of cost escalation far into the future should be kept in mind. Also, this calculation requires agreement on which lines are to be electrified, forecasts of future traffic over these lines, and detailed per-unit estimates of operating expenses and fixed plant requirements. These data are sufficient to create the cash flow profiles necessary for project planning and evaluation.

It is highly unlikely that any single interested party would undertake an investment of this size. A joint effort of some sort would be necessary. This would introduce some organizational complications which would have to be addressed in structuring participation. Organizations interested in such an electrification project would include the major Canadian railways, potential suppliers of electric power (Hydro Quebec, Ontario Hydro and Manitoba Hydro), both provincial and federal levels of government, equipment suppliers (among them locomotive and signalling manufacturers), system users (particularly bulk freight movers), and finally, external investors.

The first important step would be to determine the nature and extent of the possible commitment of each organization. Active involvement could be achieved through the following:

(i) equity participation

(ii) preferential pricing on guaranteed contracts

(iii) lease/buy arrangements

(iv) long-term guaranteed contracts (as either a shipper or power user, for example)

(v) debt.

It would be appropriate for some companies to limit their financial involvement to that part of the project of most direct interest. For example, a preferentially priced electric locomotive development program could be arranged in return for a sole-sourcing agreement for locomotives to be used on the electrified lines. Also, certain participants will emphasize some project objectives

over others and as a result, a variety of project performance criteria may be required to satisfy these needs. Most of the major participants (railways, fund investors, etc.) will require, at least, the demonstration of some financially acceptable return on investment (ROI).[37]

The role to be played by government, whether provincial or federal, will depend on political factors and budget feasibility. A number of levels of participation are possible, varying from major partner through significant but silent contributor and project debt guarantor, to serving as funds-source of last resort.

Once the potential benefits to (some of) the possible participants have been determined, the next critical step would be resolution of the project structure. As has been mentioned, the size of the project would necessitate some type of joint effort. Various joint ventures and consortium arrangements, with voting and non-voting participation, etc., are now common, but their legal and financial terms of existence are complicated as are their relationships with their corporate parents. A relatively recent and fairly straightforward corporate vehicle for structuring such a cooperative effort has been introduced in discrete <u>project financing</u>. This technique involves the packaging of the project planning, engineering and financing of major projects as a unique semi-permanent operation. By this means the potential risks and returns are evaluated on the project's own merits, and there is limited financial or legal liability on the part of some of the sponsoring organizations. Past experience with this type of project package has indicated that the relevant debt/equity ratio is not related to those of the participating sponsors and is consequently likely to be higher (65-75 per cent debt in some recent cases). The less formal nature of <u>project financing</u> also results in executive and financial flexibility.

The remaining step in putting the financing together after adoption of the project financing technique is the isolation and procurement of the debt portion. The principle sponsors would first make known the extent of their equity investment, and their inferred influence according to some final equity configuration. Insofar as electrification is concerned, the likely prospects for sponsorship must be the railways, the provincial and/or federal governments, and possibly a major private corporate investor. Use of project financing enables sponsors to segregate their liability from the balance sheets of the major corporation. Also it is usual that sponsors do not endeavour to guarantee the lenders against all risk involved. In fact, there is rarely a direct claim possible against the sponsors since much of the project risk is typically offset through project insurance.

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37 Complications posed by different definitions of <u>return on investment</u> are discussed in Section 5.3.

The debt requirement can be readily identified once the details of equity participation have been agreed upon and contract guarantee and preferential supplier agreements finalized. These two major non-debt sources of funds represent the credit support which, along with the estimated project cash flow schedule, would be presented to potential lenders. The debt requirement must be considered flexible to some degree, since it is necessary to insure that the ultimate debt line is committed to project completion and not simply to a maximum dollar limit. The project package would then be presented for consideration to the complete range of debt sources, both public and private. Among the major features of this package should be:

(i) detail of project start-up and operating risks, and probabilistic streams of costs and revenues producing an ROI figure

(ii) compensatory measures to be taken to offset operating risk

(iii) detailed list of major committed sponsors

(iv) debt capital requirement and leverage target.

5.2 ACCOUNTING AND ECONOMIC CONSIDERATIONS

The economic evaluation described in Section 2 is based on the discounted cash flow principle, an engineering economy procedure suitable for insider evaluation. Financing, however, involves both those with insider knowledge, and others who must glean their information from published accounting statements. Although the discounted cash flow evaluation concept is advocated by economists as the means of establishing criteria for maximizing shareholder (owner) return over the longer term, other considerations are important over the short and medium term. Management personnel in particular must preoccupy themselves with the shorter term; and the shorter term in this context involves outsider perceptions -- these governed by managerial success as indicated by the corporate income statement.

In this regard it is important to note that return on investment (ROI) has two definitions (the situation for return on equity is a clear parallel). To the engineering economist, ROI or Internal Date of Return is defined as the discount rate, which when applied to the net cash flows from the investment in question, would result in exactly zero net present value. From an accounting[38] or financial analysis perspective, ROI is the net income generated by an investment divided by the capital invested. The outsider or financial analyst is not necessarily oblivious to the former definition; access to data that would enable calculation of that ROI would be desirable, but circumstances limit the outsider

38 "To the accountant...," would be incorrect. Accountants are trained to apply both definitions, each in its appropriate context.

to the published financial statements, and hence to the accounting definition of ROI.

Besides access to information, there are other important differences between the accounting and the discounted cash flow approaches. Discounted cash flow only considers taxes actually paid, but generally accepted accounting principles dictate a more complicated approach. In Canada, depreciation is not an allowable expense for income tax purposes. In its stead, a diminishing balance capital cost allowance is defined under the Income Tax Act. Under generally accepted accounting principles, financial statements are calculated as if depreciation (usually straight line) were the allowable expense (as in the case of many other countries). Because an accelerated tax write-off under capital cost allowance procedure is a possible government incentive for electrification, this distinction is important. The accounting net income, and hence ROI, would be the income that would have applied without the incentive rate. The accelerated depreciation tax savings would simply be shown as a liability -- taxes payable.

It is the very long-term nature of the annual cost-savings cash flows, and their tendancy to grow over time, that makes measurement from the accounting statements most troublesome. For most projects, even after a large investment, cash flows during the early years would do little more than cover interest (assuming a reasonably high debt:equity ratio) and might well not cover straight line depreciation. Assuming that situation to obtain, the outsider would perceive a net loss. Similarly, as the years passed, net income attributable to the electrification investment would slowly grow, with ROI reaching levels of several hundred per cent. This could prove confusing to the outside investor, and confusing to the personal detriment of senior management. This financial profile clearly suggests that electrification fund-raising should not involve public issue of equity or (probably) debt, and that participation in the financing must be restricted to sophisticated organizations.

5.3 ELECTRIFICATION PROJECT GROUP

When assessing the prospective financial sources it is relevant to note the industry-specific complications that would arise in the evaluation of this particular type of project. Among them are peculiarities of the Canadian geographic and demographic context, the heavy fixed plant proportion of the investment, and the step function nature of the conversion process. with its attendant interference with on-going operations. These factors would influence the perceived project risk and consequently the terms and availability of financing. It is also important to note the institutional character and managerial attitudes of the Canadian railways. In particular, there is a substantial preoccupation with forestalling governmental interference. This

applies to CN at least as much as to CP, and even provincial roads such as the BCR and ONR prize the degree of independence they have.

Chapter 12 of the 1976 report[39] presents a schematic (reproduced here as Figure 9) illustration of options for financing the electrification investment under the admittedly simplistic presumption that the participants would be limited to the railway company, the power utility and possibly a "new utility" power supply service company. The split illustrated in the figure is probably a reasonable segregation of activities and should constitute practical split points for responsibility -- a particular difficulty in the railway industry. At the extremes, it is assumed that the local power utility would provide the generating capacity and the railway company the locomotion. Neither are necessarily entirely true, and in particular a railway owned and operated thermal plant would have distinct (economic but not political) advantages under certain circumstances.

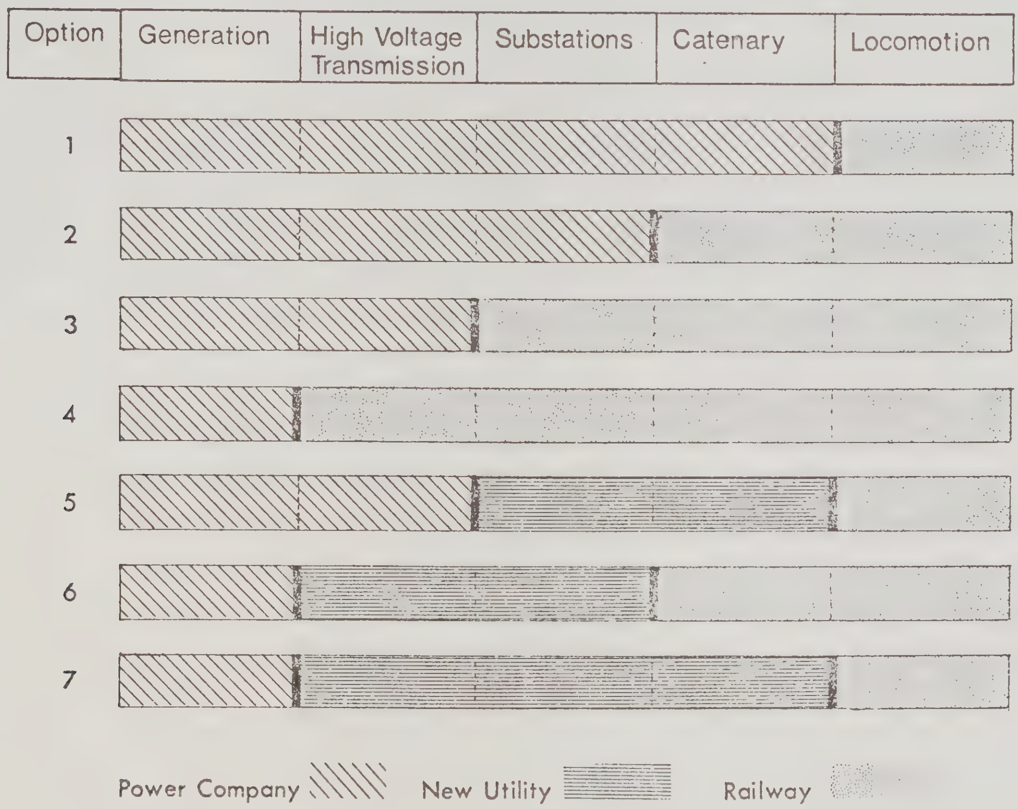

Figure 9 Illustrative electrification financing alternatives

Locomotion, including maintenance facility modifications, and adjustments to accommodate electric operation over a relatively small segment of the system, must remain a railway responsibility, even though some of the funds may come from elsewhere. Equipment trust certificates and other locomotive lease

39 "Canadian Railway Electrification Study: Phase I," <u>op. cit.</u>

arrangements are common; Canadian Pacific has financed ten per cent of CP Ltd capital in this fashion (not all of this involves locomotives, which represent substantially less than ten per cent of CP Ltd capital). Electric locomotives would, however, probably not be as attractive a leasing proposition, for they could not be freely transferred to other uses in the case of financial default. There are, however, other factors that augur in favour of leasing. It would be a suitable mechanism for participation by equipment suppliers, particularly during the early phases of conversion. The electric locomotive price used in the economic evaluation is high relative to diesel unit prices, but the production run would be relatively small, development costs high, and uncertainty substantial. With their interest in seeing the first project succeed, suppliers may well be willing to provide financing on a lease basis.

There are other conversion capital cost elements that remain a railway responsibility, but do not result in tangible assets. Clearance modifications and signalling conversion to avoid inductive interference may present opportunities for minor betterments, but for the most part they are monies that must be sunk (without identifiable return) into the conversion generally.

The principle opportunities for outside participation involve provision of the transmission lines, the substations and the catenary. Power could be sold on the basis of consumption metered on the locomotive, but this would remove the land management function from the railway and divorce them from the train scheduling function (where load balancing would be possible). Certainly, the electricity transmission facilities and substations are a logical avenue for utility company involvement, and while Ontario Hydro has not been approached -- such negotiations are better left to an organization proposing electrification, not one simply studying it -- another Canadian utility has offered to provide transmission facilities for a similar project.

It is in the financing of electrical fixed plant that government participation would be most logical, either directly or as a debt guarantor for a service utility.

5.4 THE FIRST OR PROTOTYPE SECTION

Although the size of the electrification investment is imposing, the long-term benefits will be very real, particularly in the context of a global economy faced with continued dramatic escalation in the price of hydrocarbon fuels. There will be a substantial net return from electrification, both in a conventional financial sense and in a wider "national" context. If this point can be made convincingly, the nature of financial markets will make the necessary funding available. Indeed, there are several ongoing resource-related projects, such as the tar-sands development, major pipeline construction and various

mining ventures, which are of equal or greater magnitude. Project size will not in itself be prohibitive. Rather, the initial or prototype conversion will represent the real hurdle. Benefits from this will be substantially lower than those attributable to general conversion, and cost levels will be higher. Not only will locomotive unit prices be higher, reflecting both higher development cost spread over relatively few units and the greater perceived risk to the manufacturer, but their usage will be relatively inefficient. It will be necessary to have units available at each end for trains as they arrive. Substantial benefits will be lost through the cost of interrupting trians to change locomotives, and electric locomotive maintenance facilities will be underutilized. Personnel, both operating and maintenance, will require training, and possibly retraining as experience leads to modified procedures. The experimental nature of the first segment converted to electric operation, even though the research is concerned with determining how, not whether, electrification should proceed, bears very real risk. When, as a result of operating experience, a standardized Canadian design is adopted, extensive and expensive modifications may be necessary.

It is for this prototype conversion that government participation seems most necessary. Once this hurdle is crossed, and subsidized oil prices eliminated or non-consumption equally subsidized, it is quite possible that system-wide main-line conversion would follow. It would probably only be a matter of time. Certainly, with one segment electrified at a proven cost and with measurable benefits, commercial financing would be a much easier proposition.

5.5 FINANCIAL INCENTIVE

Like many other high-technology projects, electrification suffers from the necessity for almost all the capital investment to be made before the project produces any returns to the enterprise, whether as returns to equity or funds from which debt can be serviced. Over the full course of the project, relatively large savings are returned, so that after the "payback period," when the investment itself has been recovered and the debts paid off (but when there are no net profit or return on the owner's investment of equity), the gross profit appears so large relative to the costs recorded for the current year, that customers and governments complain of the apparent "excess" profits and demand rate reductions, ignoring the early years of high investment and no profit. The capital-intensive technology project suffers not only from the risk that the project may not be profitable (successful) at all, but also, if it is profitable, with the timing of the profits the enterprise may not be able to keep them. Thus, the owner's great reluctance to take the risk without some special assurances.

One avenue for easing the financial burden of electrification which does not seem to have been properly explored is the potential influence of Capital Cost Allowance (CCA). Railway CCA rates have always been low on the basis, credible in the past, that railway assets had very long lives. More recently, special CCA classes and other tax incentives have been created to encourage new industries, or compensate for high risk. Frontier oil and gas exploration, for example, has been granted 150 per cent write-offs for exploration expense. Trucks and aircraft attract 30 per cent (Class 10) and 40 per cent (Class 16) CCA, which compares rather handsomely with the railway's typical 4 per cent (Class 1) to 6 per cent (Class 4).

The effect of special tax concessions would be to reduce substantially the early burden of capital-intensive investment, thus reducing both the inherent risk in the project, as well as the time lag of the necessary return and the risk of diversion of that return. Some risk would be added, however, in that the railways could have low profit years at the time of electrification and thus not be able to recover tax concessions.

Several possible CCA schemes are listed below. One or a combination of these may easily have dramatic effects on the commercial attractiveness of electrification to the railways, thus encouraging at least a prototype installation. There are many subleties to be examined before firm conclusions can be drawn, but preliminary calculations by us of the Thunder Bay-Winnipeg link show significant increases in Incremental Present Value of Net Savings (IPV) and rather dramatic reductions in Capitalization Payback Period (CPP). Some suggested schemes follow below.

(1) Apply new technology classifications to all electrification capital investment, e.g. Class 10 (30 per cent) for locomotives; Class 34 (50 per cent) for electrical transmission, transformers, catenary equipment, masts; Class 22 (50 per cent) for excavation and erection equipment for catenary; Class 8 (20 per cent) for signal equipment.

(2) A special 30 per cent rate for all new equipment and construction for electrification, including locomotives, spare parts inventory, transmission lines, transformers, distribution lines, catenary, masts, signal equipment, maintenance machinery, etc.

(3) A special 50 per cent rate similar to Class 34 for all new equipment used in experimental (test or prototype) routes up to 800 miles in length, plus (1) above for all future installations after test installation.

(4) A special 100 per cent rate for all new equipment used in experimental installations up to 900 miles in length, plus (1) above afterwards.

(5) Similar to (3) above, but basing 50 per cent rate recovery on "new R&D expenditures" category.

All of the above would have to be agreed to by Internal Revenue and Department of Transport before any action was taken, i.e. these are concessions needed from government to promote electrification. The new categories could be specified as applicable to Canadian manufactured goods only, thus retaining revenue for the federal government without contravening tariff and trade agreements.

6. THE BENEFITS TO ONTARIO OF ELECTRIFICATION

Electrification of one or more of the candidate routes would create a number of opportunities for Ontario, and could provide direct and indirect benefits to several levels of government and to industry. However, electrification would not be without some accompanying costs, and the proportion of industrial benefits which would be captured by Ontario-based firms is uncertain. This section identifies some of the effects associated with the electrification of the CP double track from Winnipeg to Thunder Bay.[42]

Table 27 summarizes the capital goods and services which would be purchased in the course of electrification of the Winnipeg-Thunder Bay line, and identifies some firms which would reasonably be expected to compete to supply these goods and services.[43] The actual benefits would be greater than the simple sum of these expenditures, but the quantitative impact of the multiplier factors is beyond the scope of this study. However, the larger the total expenditure, and the longer the term over which conversion is carried out, the greater this effect is likely to be. Undoubtedly, some of the benefits will not be retained in Ontario, or indeed in Canada, but the numerical impact of this is again beyond what can be done at this time.

What is apparent is that conversion to electrified operation will offer opportunities for Ontario-based industries, and would encourage the development of Canadian-owned manufacturing facilities for railway signals and electrical equipment, filling a gap that now exists. This would facilitate the development of Canadian bids on overseas projects, and thereby enhance Canada's position in the world railway market.

The potential for a substantial export (to the U.S.) is greater than might normally be the case, for eventual widespread U.S. electrification is virtually inevitable. The financial condition of most U.S. roads is, however, such that conversion is likely to be delayed beyond that of the healthier Canadian railways, and in all probability will be carried out in a <u>crisis</u> atmosphere. Established Canadian suppliers of electrification-related material and expertise could have an unusual opportunity.

There will also be the opportunity for substantial sales of electrical power. Traffic in 1980 on the Winnipeg-Thunder Bay line would require 424,330 MWh of

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42 For other candidate segments, opportunities, benefits and costs would be similar.

43 This listing is not exhaustive nor, necessarily, does it contain the most relevant firms. However, time simply did not permit further work on this aspect of the problem. In particular, Canadian (versus foreign-owned) firms should be identified as time permits.

TABLE 27

DIRECT INDUSTRIAL BENEFITS OF ELECTRIFICATION, WINNIPEG TO THUNDER BAY (CP RAIL)
($1978 Canadian, 000's)

Cost Item	Requirements	Cost	Possible Suppliers
Electric locomotives	34 units, 4000 hp 34 units, 6000 hp	$54,400 $68,340	Canadian General Electric (Toronto, Ontario) GM Canada, Electromotive Division, (London, Ontario) Bombardier/MWL Ltd (Montreal, Quebec)
Modifications to right-of-way to accommodate catenary	Increase bridge clearances	$14,100	Local contractors along route for road bridges; railway bridges may be handled by railway crews or by local contractors
Catenary	Supporting structure 27,000 units	$66,244	Algoma Steel* (Sault Ste. Marie Ontario) Dofasco* (Hamilton, Ontario) Stelco* (Toronto, Ontario) Slater Steel Industries† (Hamilton, Ontario
	Foundations 27,000 units	$51,300	Local contractors along route
	Wire	$58,220	Phillips Cable (Brockville, Ontario) Northern Telecom (Kingston, Ontario)
Substations	Twenty-two 40 MVA transformers Switchgear	$11,000 $ 5,500	Ferranti Packard Ltd (Toronto, Ontario) Hawker-Siddeley
Utility feed lines	Three-phase hookup to each substation, total of 215 km		Work would be contracted through provincial utilities
Conversion of signalling	Install a.c. track circuits	$33,800	Canadian General Electric (Toronto, Ontario) General Railway Signal (Monreal, Quebec) Wabco Ltd (Montreal, Quebec) Serro Corporation (Ottawa, Ontario)
Communicaion equipment	Shield cables from effects of interference from catenary		Northern Telecom
Mofications to existing locomotive repair facilities		$ 1,000	Local contractors (would be in Winnipeg)
Planning and engineering		$16,970	CPCS Ltd (Montreal, Quebec) CP Rail (Montreal, Quebec) Various consultants in Ontario and Manitoba
Construction supervision		$15,250	Various, in Ontario and Manitoba
Rail-mounted equipment	Cranes and "cherry picker" units for catenary installation and maintenance	$ 1,280	Pettibone (U.S.)

* poles only
† poles and line hardware

electricity, worth about $14,445,000. Of this, about 75 per cent would be obtained from the Ontario Hydro grid, with the balance coming (directly) from the Manitoba utility.

Maintenance expenditures on the electrical facilities would amount to about $2,980,000, and would create a number of new jobs. Locomotive maintenance on the Winnipeg-Thunder Bay segment would be largely carried out in Winnipeg, as is now the case with diesel units.

At the national level, electrification of this line would save 116 million litres of diesel fuel, worth about 31¢/L at 1980 world prices. Since a litre of foregone consumption should mean, at the margin, a litre of world-cost oil not imported (and thus not subsidized[44]), this would result in a national benefit of some $36,000,000 at 1980 price levels.

These benefits would not be achieved without some cost, however. Domestic requirements for diesel locomotives would decline by about 88 units, worth over $86 million in 1980 dollars as against the purchase of 68 electric locomotives at $123 million. There would be a small net decrease in locomotive maintenance labour, although traffic growth would translate this into fewer new jobs rather than layoffs.

44 The federal government can, and does, choose to subsidize consumers of imported petroleum, but it cannot effectively subsidize itself.

7. SUMMARY AND CONCLUSIONS

As an input to the Ontario Task Force on Rail Policy, this report examines briefly the possibilities and implications of electrification of portions of the Ontario railway networks.

Technical considerations with respect to electrification are examined first. The adhesion and power characteristics of diesel-electric and electric locomotives are discussed briefly and the various related technical concerns outlined. The operational capabilities of electric locomotives vis-a-vis diesel-electrics are then discussed. The particular characteristics and requirements of passenger trains, express trains and freight trains are next considered, and the capabilities of typical diesel and electric locomotives are compared for these tasks.

Electric power supply systems characteristics are then outlined and interactions between the electric power and signalling and communications systems considered.

A short history of railway electrification and its current status in various parts of the work is outlined. The various Canadian electrification studies to date are then briefly described.

Some of the general problems of transition to electric operation are next considered, with particular reference to economic and financial evaluation concerning electrification.

Requirements for technical and operational studies before electrification can proceed at full pace are discussed. Included are locomotive design requirements, train evaluation requirements, catenary design, catenary support mast spacing, the problem of low overhead clearance, electric supply system problems, signal and communication problems, locomotive maintenance requirements, catenary maintenance requirements, and the potential role of dual-mode locomotives. Particular attention is paid to operations problems associated with electrification, such as the consequences of power failure, and some of the outstanding questions concerning these aspects are listed.

In Section 2 the economic evaluation methodology used for the study is outlind in some detail. The difficulties inherent in such evaluations are discussed, in particular the need to consider carefully the cash flows involved and to discount these cash flows in order to compensate for the time value of money so that the large initial capital investments can be appropriately balanced against the delayed returns to this investment over the life of the railway. Two particular models are discussed -- the MRAIL model used for the high-speed

passenger study is briefly outlined, and the ERAIL model used for evaluation of all of the other alternatives is then discussed. The MRAIL model was used because CIGGT has just completed a comprehensive two-and-a-half year study of high-speed passenger operation in the Toronto-Kingston-Ottawa-Montreal corridor. The ERAIL model was used for the majority of the evaluations because it is more suited to evaluation of incremental electrification investment on existing freight routes. Questions of differential cost escalation of component cost rates, traffic volume growth and the special treatment of capital expenditures are considered next. The role of Capital Cost Allowance (CCA) and the selected criteria for evaluation, namely <u>incremental present value of cost savings</u> (IPV) and <u>capitalized payback period</u> (CPP) are defined.

Section 3 defines the electrification options available in Ontario, beginning with some general criteria, then listing the segments of rail line believed worth evaluation for electrification within the province of Ontario. From the list of building blocks on Canadian National, Canadian Pacific and Ontario Northland railways, seven generalized networks were selected for more detailed examination. These seven networks were:

(1) electrified Toronto-Ottawa-Montreal dedicated passenger system

(2) Canadian Pacific lines, Winnipeg to Thunder Bay

(3) Canadian Pacific lines, Thunder Bay to Montreal

(4) Canadian National routings, Winnipeg to Montreal

(5) Canadian National routings, Toronto to Montreal

(6) the GO Transit system

(7) Southwestern Ontario networks, mainly Canadian National

In Section 4, each of the selected alternatives was evaluated using the economic evaluation methodology described in Section 2. Tabulations are provided of the unit costs and savings used as input, together with the economic evaluation of each route, showing its cash flows (briefly), its incremental present value of cost savings (IPV) and its capital payback period (CPP).

It is concluded that the dedicated passenger line between Toronto, Ottawa and Montreal in its various configurations has in itself significant possibilities for providing low cost, high-speed service. A shift in traffic to such a system, however, has an adverse impact on the electrification of Montreal-Toronto freight lines. CP's Thunder Bay to Winnipeg lines have considerable annual traffic and are shown to have a promising incremental present value and a modest capitalized payback period (thirteen years). The CP line between Montreal and Thunder Bay is shown to have a considerably less attractive return

and a longer CPP (twenty-six years) because of the substantially reduced traffic volume relative to Thunder Bay to Winnipeg. CN's lines between Montreal and Winnipeg are shown to be generally in the same category as CP Montreal to Thunder Bay.

CN Montreal to Toronto is shown to have only a modest return and CPP (sixteen years), provided that current passenger services are retained. Extension west from Toronto to Windsor and Sarnia superficially has limited potential with a low return and long CPP (forty-two years). The potential for these lines could be greatly improved with significant increases in traffic brought about by the transfer of traffic to the railways due to the potential high cost and restricted availability of liquid petroleum fuels. West of Toronto there is added potential for this line if other routes were electrified.

The GO Transit electrification is shown to be modestly profitable, with a sixteen year CPP for the high density Lakeshore route. The addition of the light-density Phase II routes is shown to have a very much reduced potential. With a dramatic shift from automobile to public transit, or the concurrent electrification of the railway lines used by GO Transit, considerable savings, with a shortened payback period, is possible.

Southwestern Ontario routes, other than the Toronto-Windsor/Sarnia main lines, have almost no electrification potential because of the multiplicity of low density secondary main lines, branch lines and alternative U.S. railway connections. A consolidation of freight lines in this area and the possibility of significant diversion to the railway mode, could result in some electrification possibilities.

Due to the much higher average mainline traffic densities, it is generally concluded that, with some exceptions, electrification of Ontario railway links is considerably less attractive than electrification of some of the lines in the western provinces, but if suitable incentives could be found, such as through Capital Cost Allowance, several of the routes would become commercially attractive for electrification.

Section 5 pays particular attention to the financing of electrification, discussing possibilities of project financing, some of the accounting and economic considerations, the setting up of an electrification project group and some of the special requirements of a first or prototype operation. It concludes with an analysis of some of the Capital Cost Allowance incentive schemes which might dramatically transform the profitability and commercial attractiveness of electrification to the railways.

Section 6 discusses the benefits to Ontario of electrification in terms of industrial opportunities and also some of the general cost/benefit trade-offs available to the nation as a whole.

APPENDIX A

TERMS OF REFERENCE

TASK: RAILWAY ELECTRIFICATION

PURPOSE: TO DESCRIBE FOR THE TASK FORCE A NUMBER OF VARIED POTENTIAL APPLICATIONS OF ELECTRIC TRACTION TO RAILWAYS IN ONTARIO, OF MECHANISMS FOR FUNDING, AND OF BENEFITS TO THE ECONOMY.

OUTPUT REQUIRED:

1. A brief survey of the different systems of electrification, their advantage in different circumstances, and their typical applications around the world.

2. A brief summary of previous schemes for electrification in Canada, and their status now.

3. Description of how modern electrification techniques might be applied to a range of Ontario situations with crude estimates of capital and operating costs based on high and low traffic assumptions. Situations to be considered include:

   (a) unit trains of mineral or agricultural freight from Winnipeg to Thunder Bay, for transshipment

   (b) the same sort of train from Winnipeg to points on eastern tidewater

   (c) mixed traffic between Cochrane and North Bay, including the ONR

   (d) mixed traffic in the Toronto/Windsor corridor

   (e) high-speed passenger traffic only in the Toronto-Ottawa-Montreal corridor

   (f) freight operations in and around Toronto

   (g) implications of GO Transit electrification on other electrification schemes.

4. A method for the economic evaluation of different electrification schemes, and comparing them with the status quo approach, giving due weight to capital and recovery schedules. A corporate planning point of view should be considered.

5. A review of methods employed in other jurisdictions for meeting the heavy front-end capital requirements of electrification, leading to a discussion of alternative financing methods appropriate to conditions in Ontario and the capital market in the 1980's (reference to competition from resource development projects).

6. A dissertation on the potential benefits of the different electrification possibilities, both operating benefits and industrial benefits, with comments on cost trade-offs between higher performance and additional line capacity, on better service to users, and on opportunities for Canadian industry.

7. A commentary on the problems of transition from diesel to electric traction, and of the usefulness of "bridging" techniques; for example, the use of electro-diesels.

8. A draft report will be delivered to the Task Force by 15 July. After Task Force review of the draft, a final report will be prepared in 30 copies.

9. An oral presentation will be made to the Task Force at an appropriate time after the draft report has been reviewed.

It is expected that the consultant will use his judgment on grouping and organizing the material; in particular, on deciding on the various possible electrification schemes. In this connection the items in task 3 are intended to be examples and not a constraint.

2 June 1980

CIGGT Project No. PRO-084 CIGGT Report No. 80-2

RAILWAY TECHNOLOGY: A BRIEF OVERVIEW

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This report resulted from research conducted through the Canadian Institute of Guided Ground Transport. The report represents the views of the authors and does not necessarily have the endorsement of the University or the other participating organizations.

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16. Abstract

An overview of all major aspects of railway technology and operations, with particular emphasis on those aspects of importance to Ontario, is presented. Topics covered include history of Canadian railway industry; the railway supply industry; railway operations; passenger and freight rolling stock; track; signalling and control; a comparison of modal energy consumption and costs; and a discussion of current and needed railway R&D in Canada. Current, near-future, and long-term technology possibilities are examined.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

The Canadian Institute of Guided Ground Transport was asked by the Research and Development Branch of the Ontario Ministry of Transportation and Communications on behalf of the Ontario Task Force on Provincial Rail Policy to:

> "describe ... the characteristics and limitations of existing and future rail systems and technology, both freight and passenger, and to provide a general comparison with other transportation modes."

The emphasis in this report is on a succinct presentation suitable for a broader audience than the transportation research/planning community. Details have been outlined and numerical characterizations have been approximated to provide a "flavour" of the nature of railway freight and passenger transportation.

1.1 Early History of the Railway Industry in Ontario

In Ontario, the first railway charters for the Huron and Ontario, and the Great Western were conferred in 1833 and 1834, although these roads were not operated until 1856 and 1853 respectively, five years after the early Quebec railways. The Great Western extended from Toronto to both Windsor and Sarnia by 1858, operating on 360 miles of track. The Grand Trunk, between 1855 and 1856, opened 522 miles of track between Sarnia and Montreal. The Northern ran 95 miles between Toronto and Collingwood, beginning operations in 1853. The Buffalo and Lake Huron operated 162 miles between Fort Erie and Goderich, beginning in 1856. Other historic roads of the time included the London and Port Stanley, the Erie and Ontario, and the Ottawa and Prescott, the Port Hope, Lindsay and Beaverton, the Welland, the Brockville and Ottawa, and the Cobourg and Peterborough. These lines and many others were eventually incorporated into either the Canadian Pacific or the Canadian National systems,[1] and most of their rights of way exist today as part of these railways.

The manufacture of railway vehicles and equipment also began early in Ontario. The Canadian Engine and Machinery Company of Kingston built railway locomotives, railway cars, railway bridges, etc., for the early railways, including the Grand Trunk, Great Western, and the Northern.[2] The St.Lawrence Foundry (Wm. Hamilton and Son) opposite the old Toronto jail on Front Street, built cars and railway

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1 A.B. Hopper and T. Kearney, Canadian National Railways, "Synoptical History of Organization, Capital Stock, Funded Debt and other General Information," Accounting Dept, Canadian National, Montreal, 1962.

2 The Railways of Canada, by J.M. & Edw. Trent, Monetary Times, 60 Church St., Toronto, 1871.

track hardware. Byers and Pierce of Gananoque, Ontario, made car and locomotive springs. Canadian Railroad Lamp Manufacturing of 50 Queen Street West in Toronto, made locomotive head lamps, switch lamps, signal lamps, etc. Gartshore Iron Works, near the Great Western depot in Hamilton, made railway locomotive cylinders and driving wheels. Toronto Car Wheel Comp'y (sic) made car, tender, and locomotive wheels at their Esplanade and Alfred Street works.

Vicker's North-Western Express would forward money packages and goods, or collect bills forwarded to "Newmarket, Barrie, Penetanguishene, Collingwood, Walkerton, Owen Sound, Southington, Orillia, Muskoka District, Parry Sound, Bruce Mines, Sault Ste.Marie, Fort William, Bracebridge, etc.," via the Northern Railway of Canada.

The Bytown (Ottawa) and Prescott Railway Company, chartered in 1850, began operations Christmas Day, 1854. It was ultimately to become part of the Canadian Pacific.

The Grand Trunk Railway Co. (GTR), extended the Montreal and Kingston Railroad to Toronto, opening in 1856. It was later extended to Sarnia, despite protests from the Great Western. The GTR was built to five foot, six inch gauge, pursuant to an Act passed 31 July 1851 by the Legislature of the Province of Canada, requiring this "provincial gauge" as a condition for financial assistance under the Guarantee Act of 1849.[3] By 1872 both the GWR and the GTR had converted to standard gauge, but the Cobourg, Peterborough and Marmora remained at Provincial gauge until the railway was abandoned in 1889.

In 1872, Parliament passed Acts granting charters to the Interoceanic Railway Co.; and the Canadian Pacific Railway Co. The original charter specified that the Canadian Pacific Railway should start at Nippissing Junction (Callendar) at the east end of Lake Nippissing. Work started at Nippissing Junction in the late summer of 1882, reaching North Bay in November (Legget, 1973, p. 88). Construction continued east from Fort William, and west from Callender. By May 1885, the 657 miles between Callender and the lakehead were essentially completed. A force of some 12,000 men, 5000 horses and twelve steamboats, and over a million dollars worth of explosives were used.

In 1882, the Grand Trunk Railway bought out the Great Western Railway, and in 1888, the Midland Railway. By 1891, the St.Clair Tunnel, connecting Sarnia, Ontario, with Port Huron was in service.

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3 Robert F. Legget, Railways of Canada, Douglas, David and Charles, Vancouver, 1973.

In 1883, the Canadian Atlantic Railway, financed by Ottawa lumber baron John R. Booth, was built between Ottawa and Coteau. "J.R." also built the Ottawa, Arnprior and Parry Sound Railway, later (1899) amalgamated into the C.A.R. and eventually the GTR in 1905.

Also of note was the National Transcontinental Railway negotiated between Hayes of the GTR and Sir Wildred Laurier, leader of the Liberal government of the day (July 1903). This railway was to be built to the highest standards (4 degree curves, and 0.4 per cent grades), between Moncton, through Quebec City, directly across Northern Ontario to Winnipeg, with further construction through the Yellowhead Pass to Port Simpson (now part of Prince Rupert).

The Canadian Northern Railway started life in 1896 north of Winnipeg under those two pioneer railway builders, Mackenzie and Mann. By 1902, they had reached eastward to Port Arthur, giving them a lake linkage to a three-mile Parry Sound line, purchased in 1901, which connected to the C.A.R.. Mackenzie and Mann established their head office in Toronto in 1899 and by 1908 had built a line from Toronto to Sudbury. By 1915 this was extended to Winnipeg, through the easier terrain well to the north of Lake Superior. By 1918, the Canadian Northern Railway had over 10,000 miles of track and extended from coast to coast. In 1917, all of this trackage was taken over to form part of the Canadian Government Railway, which in 1923, with the addition of the Grand Trunk Pacific and various lesser, but equally bankrupt railways, became the Canadian National.

Clearly, the railways of Ontario played a vital part in forging not only the two great railway systems of Canada, but the nation itself.

Figure 1.1 summarizes some of the significant milestones in Canadian railway history.

1.2 The Canadian Railway Supply Industry

The size and importance of those Canadian industries which supply manufactured goods and service to the railways, both in domestic markets and abroad, cannot be omitted from any review of rail technology. Although Canada still lacks a major independent electrical or signalling supplier, all other segments of the railway market are well represented, especially rolling stock, steel rails and other track material.

Manufacture of rolling stock is dominated by Hawker-Siddeley Canada Ltd, with plants in Thunder Bay, Ontario, and Trenton, Nova Scotia. Hawker-Siddeley produces transit and commuter cars for the North American market at Thunder Bay, while its Trenton Works concentrates on freight cars for domestic and foreign

1832	• FIRST CHARTER GRANTED TO CHAMPLAIN AND ST.LAWRENCE RAILROAD
1836	• FIRST TRAIN POWERED BY STEAM LOCOMOTIVE OPERATED OVER C-AND-ST.L
1856	• GRAND TRUNK RAILWAY CONNECTING MONTREAL AND TORONTO COMPLETED
1886	• TRANSCONTINENTAL (CPR) RAILWAY COMPLETED, FIRST THROUGH TRAIN LEFT MONTREAL ON 28 JUNE
1906	• ELECTRIC TRACTION INTRODUCED ON MAINLINE SERVICE IN TUNNEL LINKING SARNIA AND PORT HURON
1923	• ACT CREATING CNR PUT INTO EFFECT
1925	• SELF-PROPELLED DIESEL-ELECTRIC RAIL PASSENGER CAR BUILT BY CN FOR SERVICE ON WEST COAST ROUTES
1940	• CENTRAL TRAFFIC CONTROL (CTC) INTRODUCED ON CN BETWEEN MONCTON-HALIFAX
1949	• CN, CP BEGAN EXPERIMENTS WITH DIESEL LOCOMOTIVES IN MAINLINE SERVICE
	• LAST STANDARD GAUGE STEAM LOCOMOTIVE PURCHASED BY CANADIAN RAILWAY WAS DELIVERED
1954	• FIRST ALL-DIESEL OPERATIONS BEGAN (CNR, ON PRINCE EDWARD ISLAND)
	• FIRST INSTALLATON OF CONTINUOUS WELDED RAIL (CWR)
1960	• LAST OPERATION OF REGULARLY-SCHEDULED TRAINS WITH STEAM LOCOMOTIVES
1961	• FIRST TEST INSTALLATION OF CONCRETE TIES (CN)
MID-1960'S	• FIRST TEST INSTALLATION FOR WAYSIDE INFRARED DETECTORS FOR OVERHEATED BEARINGS
1968	• UNITED AIRCRAFT TURBOTRAIN INTRODUCED (CN)
1978	• FULLY-AUTOMATED EQUIPMENT FOR OUT-OF-FACE REMOVAL OF TIES INTRODUCED ON CN
1979	• FULLY AUTOMATED EQUIPMENT FOR RAIL CHANGE-OUT (RCO) INTRODUCED ON CN
LATE 1981 OR 1982	• LRC TO ENTER REVENUE SERVICE WITH VIA RAIL

Figure 1.1 Significant milestones in Canadian railway history

railways. Hawker-Siddeley is also a major supplier of car components, through its Canadian Steel Wheel Division plant in Montreal and Canada's only railway axle facility in the Trenton Works. Canadian Steel Foundries, another Hawker-Siddeley subsidiary adjacent to the wheel plant, also produces a large range of castings for both freight and passenger equipment. A substantial portion of this goes to export markets in the U.S. and Mexico. Hawker-Siddeley employed about 4,100 people in these rail-related ventures; sales of railway products accounted for about half the firm's $540,000,000 net sales in 1979.

Other major Canadian car manufacturers include National Steel Car Corporation, Ltd (Hamilton, Ontario), which produces freight rolling stock for Canadian and U.S. railways, PROCOR Ltd (Oakville, Ontario), which specializes in the manufacture and lease of tank cars, covered hopper cars and other specialized rolling stock, and Marine Industries Ltd (Sorel, Quebec), which manufactures general-purpose freight rolling stock.

Motive power manufacturing is the shared domain of the Diesel Division of GM Canada (London, Ontario) and Bombardier/MLW Ltd (Montreal, Quebec). The GM facility, which produces locomotives for Canadian use with limited export production, is really an outstation of the U.S.-based Electro-Motive Division. Bombardier, on the other hand, is an entirely Canadian firm that currently does most of its business in export markets, although its new line of HRC locomotives and its involvement, together with Alcan and Dofasco, in the development of the LRC, suggest that in the future it will again be a major factor in domestic sales.

Canadian Vickers Ltd (Montreal, Quebec) has in the past produced vehicles for rapid transit and commuter services, including bi-level coaches, as well as components. However, this firm now appears to be losing interest in the passenger rail market.

Upwards of ten Canadian firms supply track materials -- ties, rail, rail fastenings -- to the railway industry and for export. These include very large companies like Algoma Steel (Sault Ste. Marie, Ontario), Steel Company of Canada (Hamilton, Ontario), and Sydhey Steel Corp. (Sydney, Nova Scotia), as well as smaller firms specializing in rail-related products. Ballast materials may be purchased locally, procured from railway-owned sources, or by contract with larger firms (both Inco and Noranda Mines sell base-metal slags to CN and CP for use as ballast materials).

A large number of firms (over 40) are involved in the manufacture and/or distribution of maintenance equipment. The major domestic manufacturers include Canron Rail Group (Toronto, Ontario), which produces a broad line of automated track

maintenance equipment. Unfortunately, many of these firms act only as distributors for products manufactured abroad.

In addition, there are many firms like Canadian General Electric, the IEC Holden Company, and Canadian Cardwell which supply the specialized firms with standard components or subassemblies. It is much more difficult to identify the railway component of these organizations, but it is substantial.

Domestic sales by these railway suppliers totalled over $400 million in 1979, with over 10,000 employees in the rolling stock industry alone. Canada is also becoming a force in export markets. Between 1972 and 1978, export sales averaged over $140 million annually. About two-thirds of this volume went for rolling stock, with another quarter for rail and other track components. The balance was for management and consulting services, an area in which Canada has an excellent (and growing) international reputation.

2. RAILWAY OPERATIONS

While railways throughout the world are superficially similar, there are many underlying physical and operational differences, reflecting the varying roles which railways are expected to play within different economies.

In Canada, the principal demand on railways has been for the long-distance movement of bulk commodities and manufactured goods, although the demand for short-distance intercity freight is vigorous in some markets, and some passenger services are showing signs of regrowth. Consequently, economics has demanded that generally freight trains be comprised of large numbers of heavy cars, operated at relatively modest speeds and comparatively infrequent intervals.

This type of freight service is in direct conflict with the requirements of an attractive passenger service -- high speeds and departure frequencies, together with very high standards of track maintenance. Operation of the two services on the same track, as is necessary on the Canadian system, results in reduced line capacity, delays to either or both of the services, and either excessive track maintenance costs or a less than satisfactory ride for the passenger trains.

Railways in Japan and Western Europe present quite a different profile. A combination of economic, demographic and geographic factors has resulted in an emphasis on intercity passenger service, with freight operations taking a secondary position. Freight is handled in smaller, lighter cars and shorter, faster trains than in North America; sometimes they only operate at night. In some cases, passenger train densities are sufficient to justify dedicated passenger trackage, permitting higher speeds and departure frequencies than would otherwise be possible.

2.1 Line, Yard and Terminal Operations

Both technology and operating procedures of North American railway operations have undergone substantial changes during the past twenty-five years. The need for increased transportation productivity has led to larger, more complex freight cars and locomotives, and to longer, heavier -- and sometimes faster -- freight trains. These changes have, in turn, led to improvements in track structure design and maintenance procedures. Less obvious, but equally significant, has been the implementation of computerized car control systems, single-commodity (unit) trains, and coordinated intermodal freight services.

The overall structure of a railway system exists to move goods and/or people from one location to another -- to provide what an economist might term "place utility." The economic accomplishment of this apparently simple task can pose complex problems, especially on large systems like those of CN and CP. The makeup of the fixed plant of the railway reflects management effort to achieve an optimal solution to this transportation problem.

The fixed plant of the railway can be divided into two major categories: yards and line. Normally, yards are categorized in terms of the major operating function carried out therein. On that basis, six yard types can be defined:[4]

- Classification Yards
- Interchange Yards
- Storage/Support Yards
- Local Switching Yards
- Intermodal Terminals
- Other Yards and Terminals

A classification yard is responsible for three major functions -- the reception function, in which an incoming train is placed in the receiving yard to await classification; the classification function, during which the train is broken up into individual cars or blocks of cars, with each car or block being placed onto a classification track corresponding to its general destination; and the departure function, which assembles groups of cars from different classification tracks into a single train which will move these cars closer to their final destinations.

The classification segment of a yard may be either a hump yard, as shown in Figure 2.1(a), or a flat yard, as shown in Figure 2.1(b). Major classification yards, such as Canadian National's MacMillan Yard in Toronto, are typically hump

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4 United States Federal Railroad Administration Report No. FRA-R&D-75-55, "Railroad Classification Yard Technology."

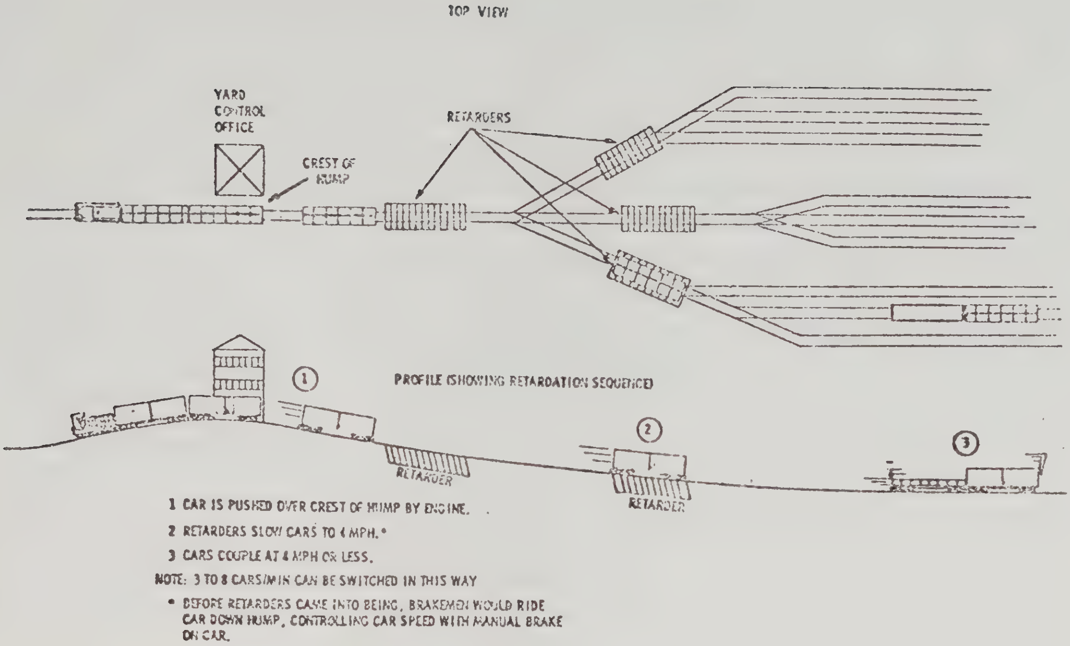

Figure 2.1(a) Hump yard classification procedures

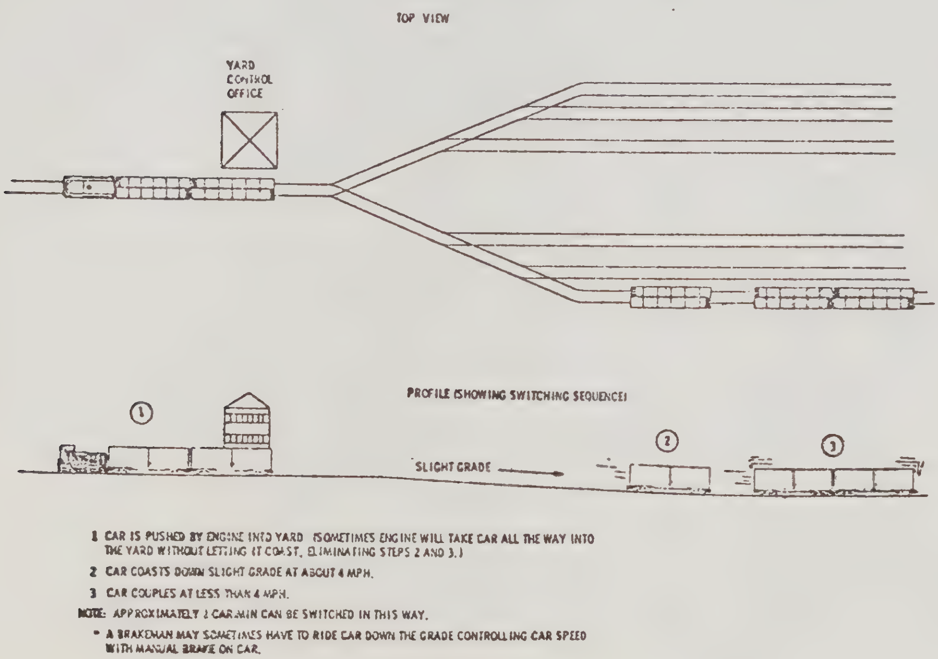

Figure 2.1(b) Flat yard classification procedures

yards. Cars are pushed over the hump and roll freely downhill to their proper track, with their speed controlled by mechanical and electromechanical "retarders" built into sections of track to limit the car velocity at coupling to four miles per hour. CN has five modern hump yards, and CP three.

Smaller classification yards are almost always of the flat yard type, constructed on level ground or on a slight grade. Cars are pushed by a locomotive and then released, coasting to their respective tracks. Retarders are not normally required.

Interchange yards are used to handle cars being transferred from one railroad to another. Usually, cars from one railroad destined for a connecting railroad will be placed on a designated connecting track. A locomotive from the receiving railroad will then pick the cars up at that point. This interchange of cars among North American railways -- often termed interlining -- facilitates the movement of goods without the need for expensive, time-consuming transshipment. Revenues and costs are shared among the participating railways in a predetermined fashion. However, this process can produce a range of problems, including car shortages arising from the slow return of interlined rolling stock and damage resulting from variations in maintenance standards or operating procedures. Interlining also poses a problem for the introduction of new technology -- for example, articulated trucks on freight cars -- since the benefits resulting from reduced wear on track and vehicle components would not necessarily go to the railway that paid for the improvement.

Storage/support yards are yards where cars, generally empty, are stored until needed. Storage/support yards can also be used for storing old locomotives, cars in disrepair, unused rolling stock, and maintenance of way equipment. In some cases, cars loaded with a commodity, such as coal or grain, are stored pending shipment on short notice or to await unloading at a port facility. In general, storage yards fulfill a variety of holding requirements in rail networks.

Local switching yards are small yards used for the handling, sorting and storage of traffic related to local freight service for industries, interchange movements, large shippers, and general local car handling needs. Unlike classification yards, local yards are not usually used to assemble and break up main line trains. Some branch line local trains and local switching "blocks" may be made up in the local yards, but large-scale classification activity there is unusual.

Intermodal terminals are specially designed yards where truck-trailers and/or containers are loaded on and unloaded from flat cars. These facilities often dispatch and receive intermodal trains directly, thereby avoiding the usual classification yard process.

Other yards and terminals are designed to handle specific commodities or functions. Special loading and unloading terminals for coal, ore, and automobiles, and maintenance terminals dedicated to passenger equipment, such as the GO-

Transit Willowbrook facility (near Mimico), typify these special-purpose facilities.

The other major component of railway fixed plant, line, is made up of the track structure and signalling and control systems which form the connections between major centres (mainline track) or between the main line and the shipper or receiver (industrial sidings, branch lines and spur lines). These groupings are largely based on the importance of the end points connected by the track and on the types of operations which are performed on the line segment. Thus, the CN link between Toronto and Montreal is a double track main line, while the CN track connecting Marmora to the main line (at Trenton Junction) is a single track branch line. Spur lines connect tracks owned by a specific shipper or receiver to either a main or branch line; the track serving the tank farm at the Bath generating station would be a spur line.

The typical process of moving freight by rail is:[5]

(1) shipper orders empty freight car from railway agent

(2) yard office receives order and selects car

(3) selected car inspected for mechanical soundness and special shipper requirements

(4) car is switched to shipper's track for loading ("spotted"); this is performed by industrial switch engine

(5) shipper loads car and notifies agent that car is ready to be picked up ("pulled")

(6) bill of lading and waybill are prepared for the shipment

(7) industrial switch engine moves car from shipper's track to classification yard

(8) car is classified into train of cars with generally similar destination

(9) road engine picks up train and begins linehaul movement

(10) during linehaul, car may pass through one or more intermediate classification yards, each time being placed in a train moving closer to its final destination

(11) on arrival at destination, train is broken up, and steps 8, 7 and 4 are performed in reverse

(12) consignee unloads car and notifies local agent of its release.

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5 Where goods are regularly shipped in trainload lots, the process is simplified.

2.2 Current Trends in Railway Operations

Traditional railway operating practices have undergone considerable modification in recent years, primarily as a result of innovations designed to meet specific market conditions. Several of the more significant of these are discussed in the following sections.

2.2.1 Automated Car Control

The complex problem of car control -- in essence, knowing how many cars of a given type are available, where they are, how many are needed at a given location, and where each loaded car is located and when it can be expected at destination -- has long plagued railway operations. Poor car control is typically characterized by long cycle times,[6] "lost" loads, and an overly large car fleet.

To overcome this problem, more and more railways have turned to computerized car control systems, such as the TRACS car reporting system in use on Canadian National. Canadian Pacific has a similar car monitoring scheme, centred in its System Car Management Centre in Montreal. These systems have enabled the railroads to increase freight car productivity. On CN, for example, the car cycle dropped from 17.2 days in 1975 to 12 days in 1979, representing a potential saving of about 12,000 cars -- worth on the order of $540 million dollars.

An automated car control system also allows customers to find out where their loads are located through on-line terminals, and allows more efficient utilization of maintenance facilities. The CN system provides daily inventories of bad-ordered (out of service) cars to headquarters and regional management and to the car repair shops. Scheduling of repairs is based on the need for car types within the region. This approach has reduced overtime costs by facilitating better planning and utilization of repair facilities and manpower.

2.2.2 Unit Trains

Traditional railway freight movements are of the "move-sort-move" variety, with yard classification interposed between each line movement. This approach to freight handling is completely unsuited to continuous process operations, such as mines, steel mills, generating stations or refineries, and is undesirable for some highly seasonal traffic (grain, potash). The solution has been the unit (or solid) train -- a train made up of a fixed number of cars with identical or

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6 A car cycle is determined by the number of loaded trips made by a car, divided into 365 days.

nearly identical characteristics operating between a single shipper (for example, the Luscar Sterco mine near Coal Valley, Alberta) and a single destination (Thunder Bay Terminals transshipment facility)[7] on a regular cycle (six days), with no classification and reassembly en route. Unit trains are characterized by heavy cars (axle loadings in excess of 30 tons), large trailing weights (10,000 to 15,000 tons gross) and moderate speeds (up to 50 mph (80 km/h) for a loaded coal train on the run described above). In addition to head-end power, locomotives may be positioned near the middle of the train to reduce drawbar forces and, in some types of terrain, to minimize dynamic train action. These mid-train locomotives may be remote (radio) controlled from the head-end units.

Unit trains give the benefits of high productivity and relatively low direct operating costs, but they can result in above average track maintenance requirements (due to the high axle loads), and require special scheduled car maintenance procedures.

2.2.3 Intermodal Services

Intermodal services -- moving containers or road trailers on either flatcars or specially-designed rolling stock -- have been an area of very substantial growth over the past five years. CN's intermodal operations have increased by 60 per cent over that period, to the point where it now constitutes about 10 per cent of total traffic. In the longer term, a particularly significant railway objective is the capture of more of the short-haul intercity high volume traffic, most of which is now hauled in truck trailers.

In an attempt to penetrate this service-sensitive market segment, the railways are stressing operating procedures that will give consistent on-time overnight service, mechanized terminal operations, direct entrance and departure and well-designed terminal layouts.

2.2.4 Other Specialized Terminals

Specialized terminal facilities for handling bulk commodities like coal and iron ore, or for the maintenance of rolling stock and motive power used in dedicated passenger or freight services, are becoming more commonplace. Although each facility is designed for a specific function or set of functions, all share

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7 This $70 million port facility was constructed especially to handle the transshipment of thermal coal destined for Ontario Hydro generating stations from unit trains to Great Lakes bulk carriers. The installation can handle up to 12 million tons throughput annually, and can stockpile as much as five million tons of coal.

certain common elements, most notably high productivity achieved through mechanization and careful facility layout.

Maintenance facilities for passenger trainsets such as British Rail's HST or the French National Railways' TGV and indeed for the GO-Transit commuter equipment also differ from traditional yards and shops. The emphasis again is on improved utilization and reduced downtime. Figure 2.2 shows a schematic representation of work flow through British Rail's Heaton depot, which handles servicing and maintenance for both HST and conventional passenger rolling stock.

3. EQUIPMENT

3.1 Passenger Rolling Stock

The fundamental difference in outlook and purpose between North American railways and those of Western Europe and Japan is perhaps most noticeable in the differences in current passenger rolling stock and service quality. The rail systems of Europe and Japan are oriented to the provision of fast, comfortable, frequent passenger service over track of superior quality. With very few exceptions, North American rail passenger services do not reflect these characteristics, although some improvements have occurred since the advent of AMTRAK in the U.S. and more latterly VIA Rail in Canada.

With few exceptions, passenger rolling stock built in North America is much more heavily constructed than contemporary European or Japanese vehicles. In essence, U.S. and Canadian passenger cars must meet the same standards of strength[26] as freight rolling stock, despite the fact that passenger cars are never subjected to classification-yard impacts. The rationale -- other than tradition -- appears to stem from concern over mixed operations, both in the sense of freight and passenger cars being operated together in a single train consist, as is the case in many North American routes, and in the sense of freight and passenger services operating over the same track but in separate trains. This is of some real concern, but the additional weight neccessitated by these standards makes it difficult to match European performance.

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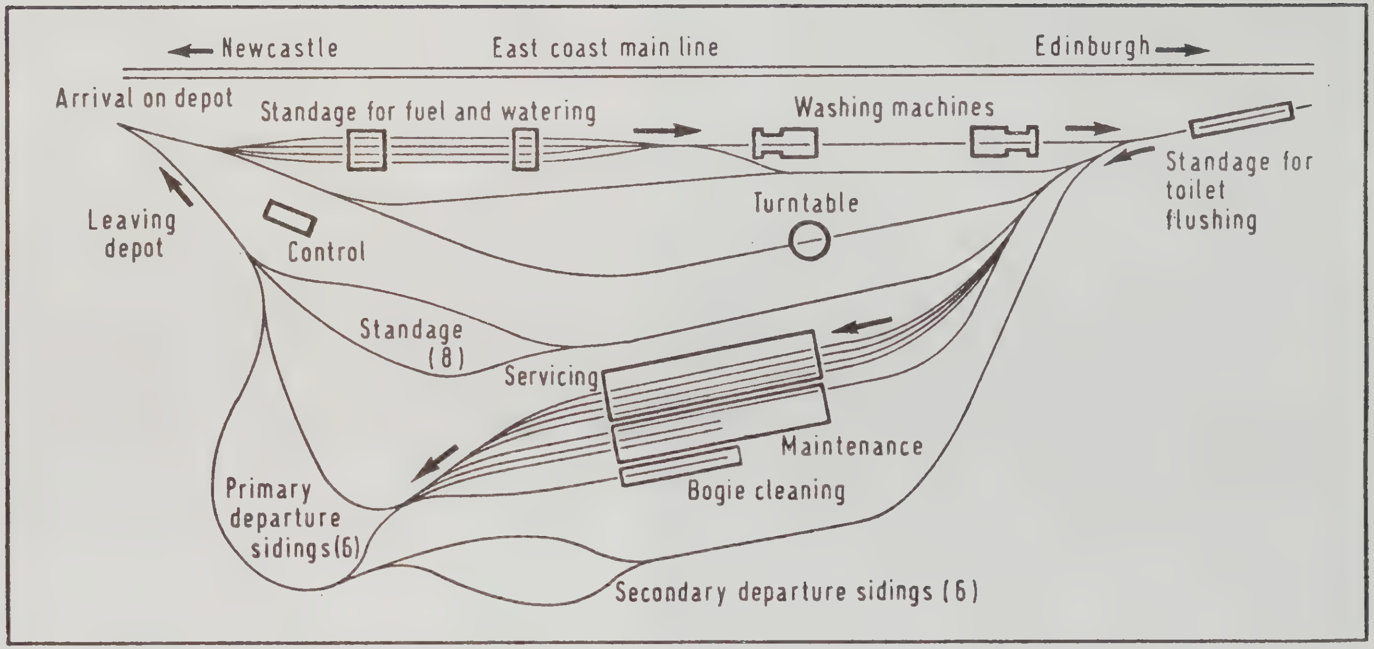
26 Especially the requirement that the vehicle resist 800,000 lbs. of force in compression. European passenger vehicles are generally designed for 300,000 to 400,000 lbs. butt loads.



(after Railway Engineer International, July/August 1978)

Figure 2.2 Schematic of work flow through BR's Heaton depot

3.1.1 Canada

In Canada, the average age of the passenger coach stock is 27 years, and many of the diesel locomotives used in passenger service are over twenty years old. Only the United Aircraft Turbotrains (Figure 3.1) and the Tempo coaches (Figure 3.2) are more modern. However, this equipment is well maintained and efficiently operated, particularly in the Montreal-Toronto corridor (and to a slightly lesser extent between Toronto and Windsor) where the service is of a comparatively high quality. Both the Turbo and Rapido (Figure 3.3) services maintain average start-to-stop speeds (excluding station dwell times) in excess of 80 mph on the Guildwood-Kingston and Kingston-Dorval segments of the Montreal-Toronto route. The legal maximum speed on this route is 95 mph.

VIA Rail Canada Inc. has fifty LRC coaches and 22 locomotives on order, but these will serve only to replace a limited portion of the current fleet with existing technology. Although needed for replacement, the LRC (Figure 3.4) will not represent a significant advance in performance over the existing Rapido and Turbo services, but comfort and reliability should be improved. Both the total mass and unsprung mass of the LRC locomotive are too high to permit operation at speeds over 95 mph without excessive track damage from dynamic wheel-load. The solution, which has gained wide acceptance throughout the world, is to reduce wheel-loadings, and especially the unsprung mass. This has been achieved with all of the newer types of passenger equipment on the French National Railways and with the British High Speed Train (Figure 3.5) and Advanced Passenger Train (Figure 3.6). A return to more extensive use of aluminum and the use of frame-hung (rather than axle-hung) traction motors would help the LRC locomotive meet these requirements.

3.1.2 United States

AMTRAK service in the United States, while continuing to suffer from inadequate track standards and the railways' lack of enthusiasm, has been improving steadily over the past few years in response to a serious commitment on the part of Federal (and State) authorities. The resulting infusion of capital funds has allowed the acquisition of a large fleet of modern Amcoach (Figure 3.7) and Superliner (Figure 3.8) rolling stock and General Motors diesel-electric locomotives capable of 120 mph speeds. Concurrently, the massive North-East Corridor improvement program, scheduled for completion in the early 1980's, has been upgrading track standards and emplacing electric catenary to allow high-speed electrified running between Boston and Washington. Modern electrified locomotives (Figure 3.9) are now entering service on segments of this route, while the existing fleet of Metroliner Electrified Multiple Unit (EMU) trainsets (Figure 3.10) are undergoing refurbishment. Less dramatic but significant improvements in service quality have occurred in other corridors, notably Los

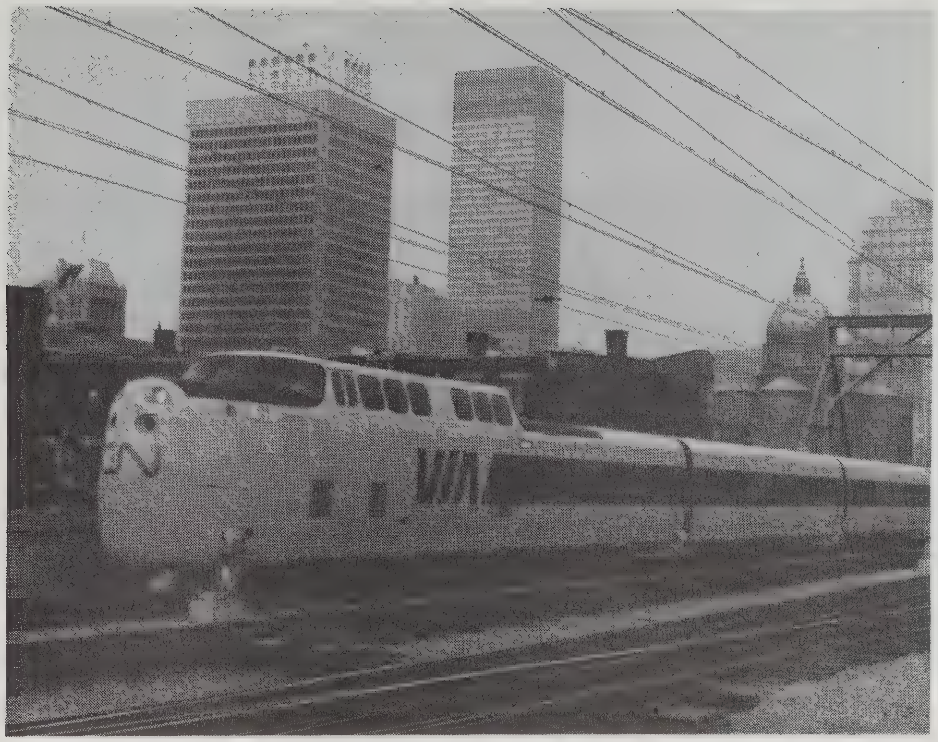


Figure 3.1 United Aircraft Corporation Turbotrain (acquired 1964-68, rebuilt 1970-73)

Figure 3.2 Tempo stainless steel coaches (acquired in late 1960's)

Figure 3.3 Typical "Rapido" consist

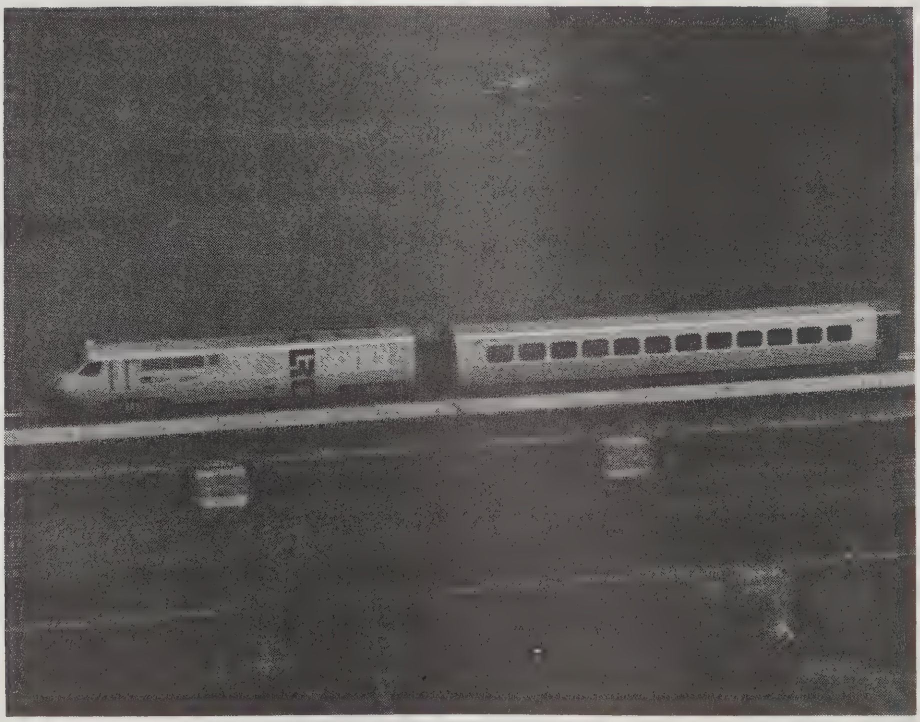
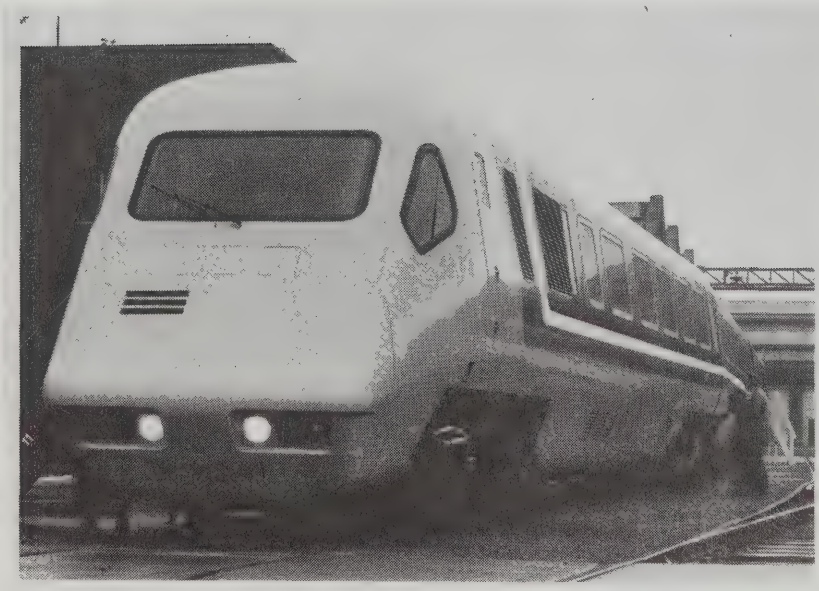


Figure 3.4 Prototype LRC locomotive and coach

(BR Photo)

Figure 3.5 British Rail's High-Speed Train (HST), now in fleet service



(BR Photo)

Figure 3.6 The Advanced Passenger Train (APT) capable of 250 km/h, which will enter service in 1981

(Amtrak Photo)

Figure 3.7 Amcoach - standard Amtrak coach rolling stock

(Amtrak Photo)

Figure 3.8 Equipped with Superliner cars, the Empire Builder prepares to leave Belton, Montana, the western gateway to Glacier National Park. The latest in American rail passenger transportation, the Superliner fleet sets a new standard for luxury and reliability in rail travel

(Amtrak Photo)

Figure 3.9 AEM-7 electric locomotive for high-speed service in Northeast Corridor

(Amtrak Photo)

Figure 3.10 Metroliners - now undergoing refurbishment, are used for electrified running in Northeast Corridor

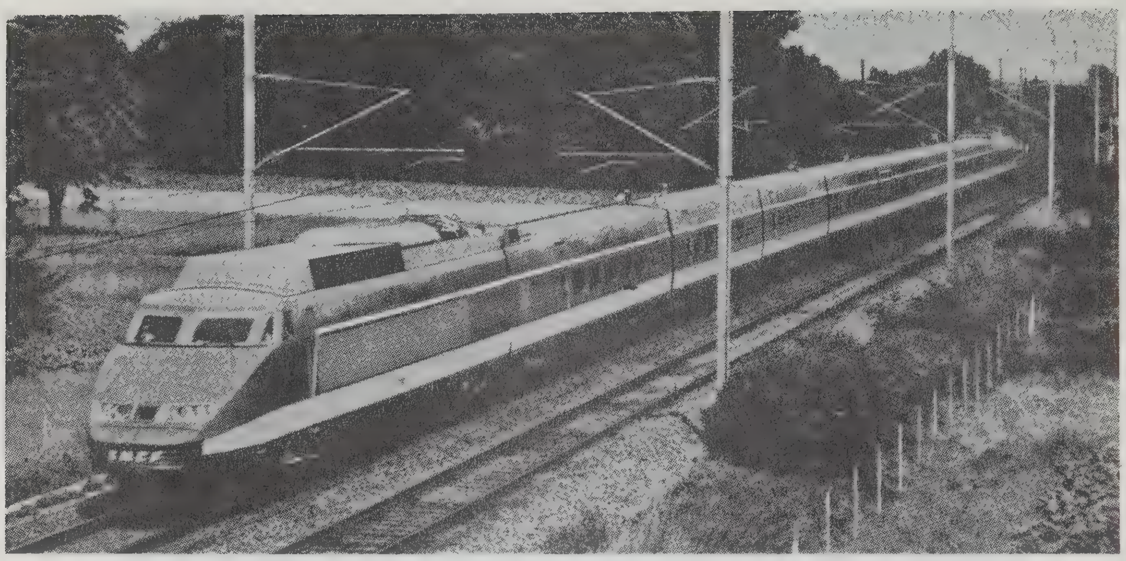
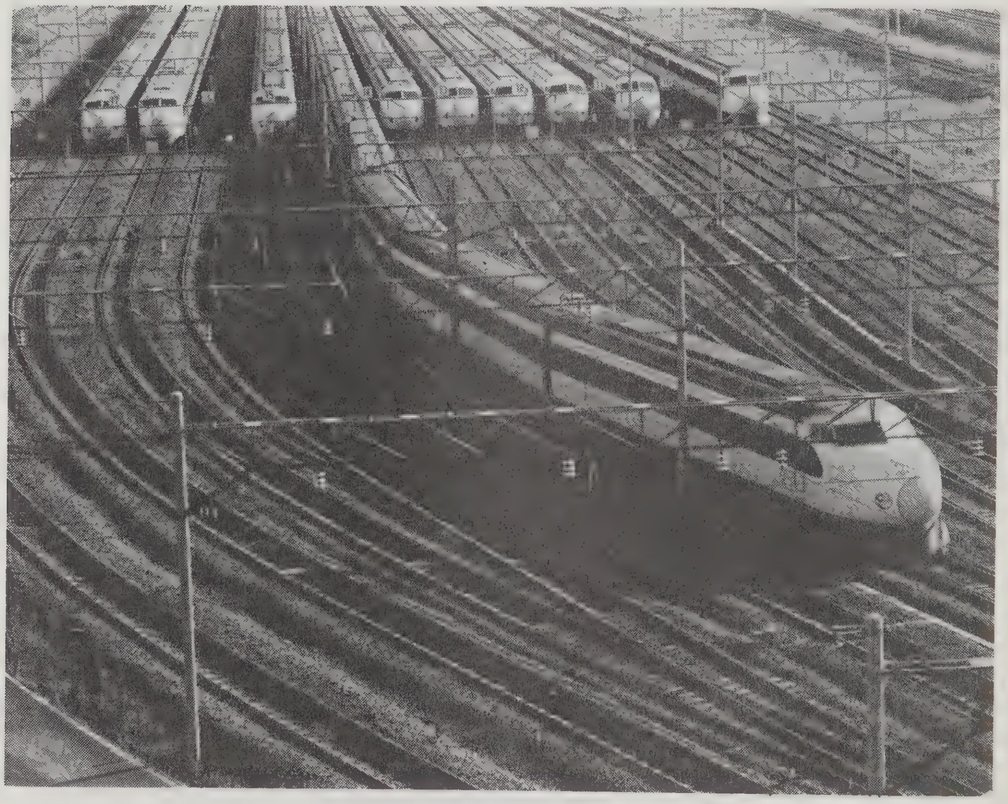
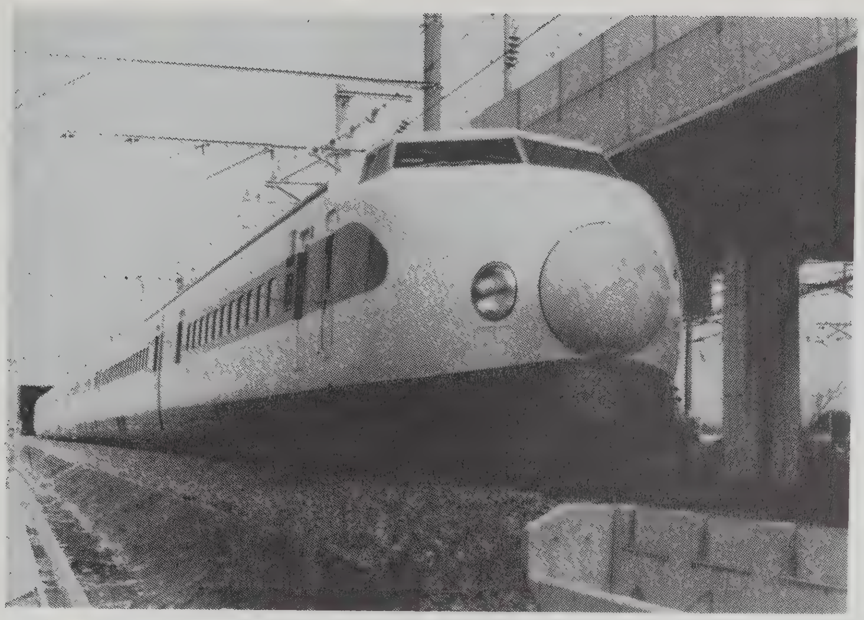


Figure 3.11 French National Railway's electrified TGV, scheduled to provide 260 km/h service between Paris and Lyons, starting in 1981



(J.N.R. Photo)

Figure 3.12 Shinkansen trainset now in service

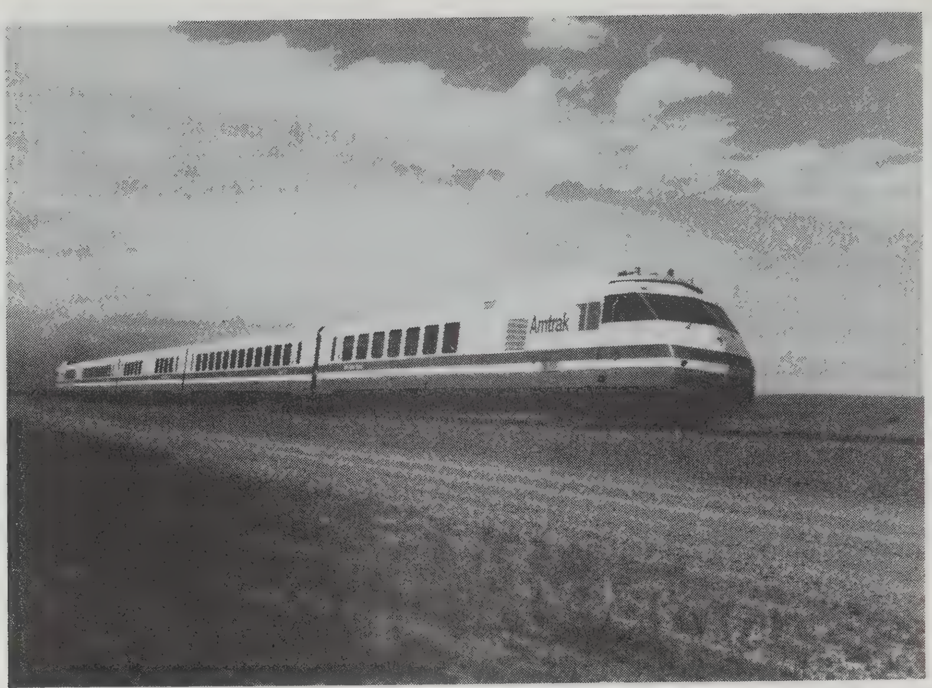


(J.N.R. Photo)

Figure 3.13 Shinkanesen Type 961 prototype undergoing test. This trainset has reached speeds of 319 km/h. Note "snow plow" front-end facing

(Railfare and Railroad)

Figure 3.14 The Ontario Northland has adapted two FP7's to power two of its four TEE "Northlander" trainsets. The two remaining European locomotives will be replaced by FP7's shortly. The FP7's have head-end power (HEP) and modified rears



(Amtrak Photo)

Figure 3.15 ANF-Frangeco/Rohr Turbotrain (as delivered to Amtrak)

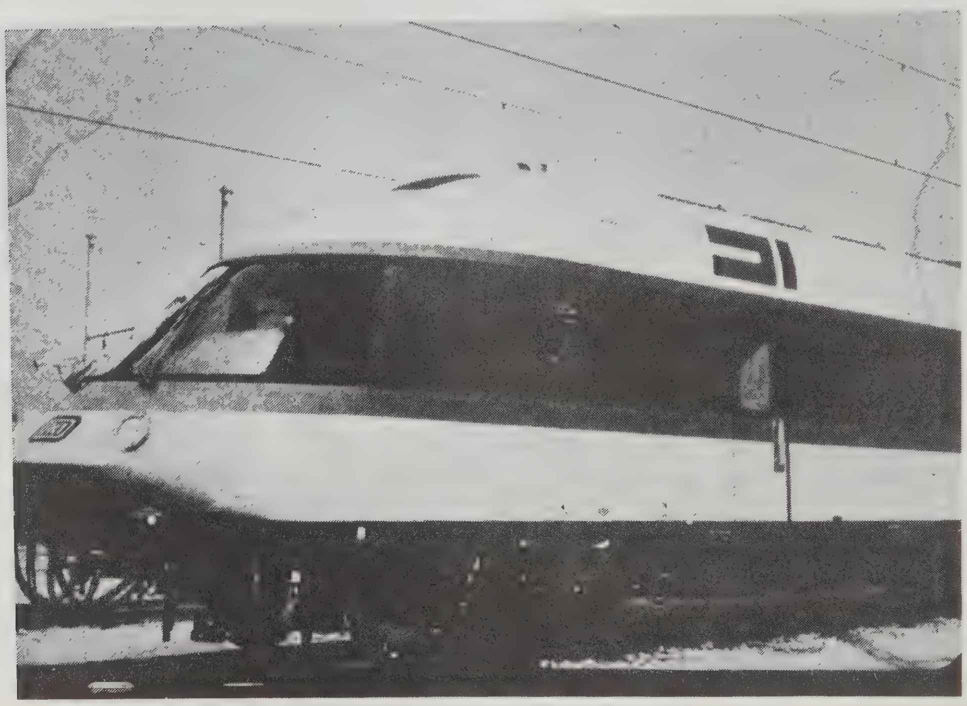
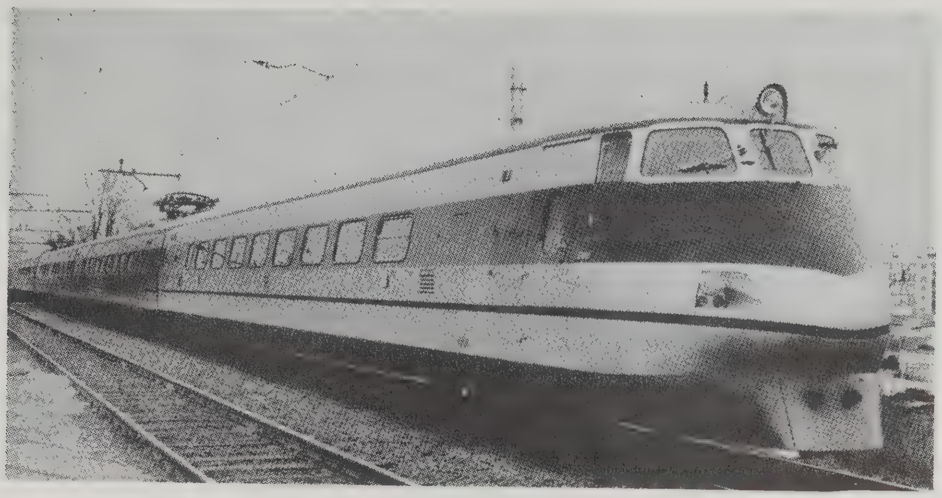


Figure 3.16 Power car, ET-403 trainset (West Germany)



(International Railway Journal)

Figure 3.17 Fiat ETR-401 "Pendoline" (Italy)

(Railway Gazette International)

Figure 3.18 "Talgo" passive tilting-body articulated coaches (Spain). Note similarity of single-axle wheelset to that of U.A.C. Turbo

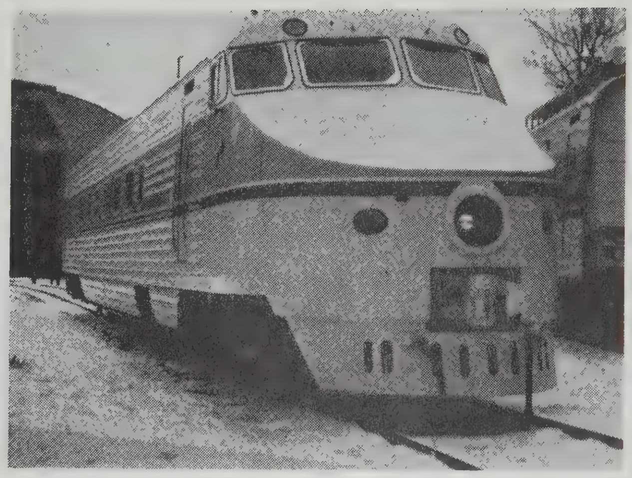


Figure 3.19 ER-200 driving car (U.S.S.R.)

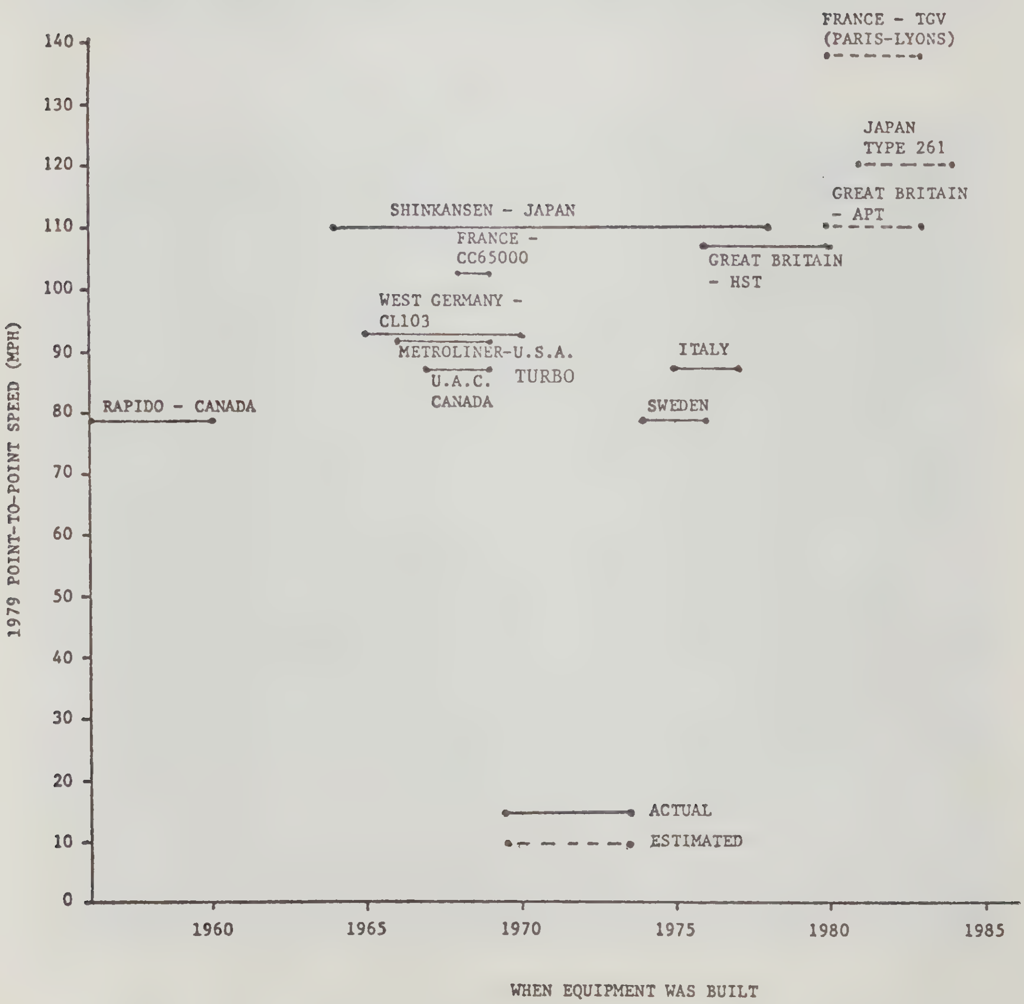


Figure 3.20 1979 point-to-point operating speeds for modern passenger services

Angeles-San Diego, where train frequency is up to eight per day each way, and several runs are fully covering costs.

3.1.3 Western Europe and Japan

The trends in passenger services in Western Europe and Japan can be characterized along two dimensions -- an increasing proportion of services with operating speeds of 200 km/h (125 mph) or more, and a shift to electrified propulsion on mainline and heavily-used secondary routes. Even British Rail (BR), which has enjoyed unprecedented success with its diesel-powered, high-speed trainsets (HST) in "Intercity 125" service, has indicated a desire to shift to fully electrified operations for its mainline network. The next generation of European rolling stock, as typified by BR's Advanced Passenger Train (APT) and the French National Railways' (SNCF) TGV (Figure 3.11), has been designed for use on electrified lines with maximum speeds of 250 to 260 km/h (155 to 160 mph).

Japan already has a high proportion of electrified track, and has recently committed itself to further electrification. Although the Shinkansen ("Bullet Train") (Figure 3.12) mainline service is unquestionably the most famous (and profitable) high-speed passenger rail service in the world, many secondary and feeder lines have also been converted to electric traction, a trend which may become more pronounced elsewhere as the price of diesel fuel continues to increase. Extensions to the existing Shinkansen network are proceeding apace, and the next generation of vehicles (Figure 3.13) for this service will be capable of 260 km/h operation, despite some earlier difficulties related to trackside noise, current collection and snow removal in the north. This high-speed service has already demonstrated its ability to substitute for more costly, less energy-efficient short-haul air operations, a major consideration for Japan, which must import virtually all its energy requirements.

Table 3.1 summarizes current rail passenger rolling stock in use in Canada and the U.S., while Tables 3.2(a) and 3.2(b) provide a similar summary for Europe and Japan. Near-future technology is summarized in Table 3.3. Figures 3.14 through 3.19 illustrate other current and near-term passenger rolling stock, while Figure 3.20 shows the 1979 point-to-point operating speeds for a number of existing passenger services, and the corresponding estimated speeds for three planned services.

3.1.4 Self-Propelled Vehicles

Self-propelled vehicles (SPV's), such as the Budd Rail Diesel Car (RDC) (Figure 3.21) now operated by VIA Rail Canada Inc., have a long history of successful

TABLE 3.1

CURRENT PASSENGER ROLLING STOCK - NORTH AMERICA

Country	Current Technology							
	Designation	Propulsion	Configuration	Design Speed	When Built	Poutings	Fleet Size	Other Features/Comments
Canada (VIA Rail Canada Inc.)	Turbo (United Air-craft Corp., Figure 3.1)	Gas Turbine	9-car fixed-consist articulated trainset	Max.: 223 km/h; Sus-tained: 138 km/h (limit is 145 km/h)	1964-68 (rebuilt 1970-73)	Toronto-Montreal	2 trainsets	Passive tilting body; single-axle shared wheelsets. Has proven unreliable in service.
	Rapido (Figure 3.3)	Diesel-Electric	Variable consist	125 km/h, sustained	Variable; coaches: pre-1960	Toronto-Montreal	Rapidos trains are made up of locomotives, coaches and club cars * drawn from the stock of equipment listed below	Conventional heavy-weight rolling stock and diesel locomotives; ride is better than that of Turbo.
	VIA Rail Canada Inc. owns the following equipment:						148 diesel locomotives; 2 Turbo trainsets; 85 RDC units; 25 Tempo cars, 365 coaches, 124 dining/ lounge cars, 288 sleepers; 201 baggage/ heating/ generator cars	All rolling stock except for Tempo cars and Turbo trainsets is pre-1960
Ontario Northland (Figure 3.14)	Northland/ Northlander	Diesel-elec-tric	Fixed consist, ex-Trans-Europe Express trainset (1 power car, 3 coaches)	approx. 140 km/h	1960	Toronto to North Bay/ Timmons	4 trainsets	Original power cars have been replaced (1979/80) with modified EMD FP-7 locomotives; the aging European-built diesels were too difficult to maintain
United States (AMTRAK)	Metroliner (Figure 3.10)	Electric	Multiple-unit trainsets	Max.: 192 km/h; Sustained: 147 km/h	1966-69	Northest Corridor	61 vehicles	Now being refurbished
	AmFleet (Figure 3.7)	-	Standard low-level inter-city coach	Up to 192 km/h	1973-78	Mostin NEC, but some elsewhere	492 coach or coach/cafe units	Stainless steel construction.
	Superliner (Figure 3.8)	-	Standard bi-level long-distance	Up to 192 km/h	1975 to present (still in production)	Western U.S.	284 (when deliveries are completed)	Operated on head-end electric power; stainless steel bodies
	SDP40F (General Motors)	Diesel-elec-tric	3000 hp diesel-elec-tric locomo-tive	UP to 192 km/h	1973 to present	In use on most routes	150	-
	E60CP (General Motors) (Figure 3.7)	High-speed electric locomotive	5100 hp electric locomotive (12.5/25 kV)	192 km/h	1973 to present	NEC	26	Six-axle units
	F40PH (General Motors)	Lightweight diesel-electric	3000 hp diesel-electric	n/a	1975 to present	n/a	40 (some still on order)	-
	P30CH	Diesel-electric	3000 hp diesel-electric locomotive	n/a	1974 to present	n/a	25	-
	RTG-TURBO-TRAIN (ANF-FRANGECO/ ROHR) (Figure 3.15)	Gas turbine	5-car train-set, bidirec-tional, 280 passengers/ trainset	200 km/h	1974-77	Chicago-St. Louis; Mil-waukee-Detroit; New York-Albany-Buffalo; New york-Montreal	13 trainsets	-

TABLE 3.2(a)

CURRENT PASSENGER ROLLING STOCK - WESTERN EUROPE

	Current Technology							
Country	Designation	Propulsion	Design Speed	Speed	When Built	Routings	Fleet Size	Other Features/Comments
Britain	High-speed train (HST) (Figure 3.5)	Diesel-electric (2x2, 250 hp)	2 power cars, 7 or 8 Mk III high-speed coaches	200 km/h plus	1976 to present - production will terminate in 1981	London-Swansea; London-Leeds; London-York-Edinburgh-Aberdeen	91 to 110, depending on final route configuration	Bidirectional operation; low axle loadings (<17 tons)
France	CC 65000	25 kV a.c. electric, rated at 5900 kW	locomotive	220 km/h	1969	Paris-Bordeaux; Paris-Lyon-Marseilles; plus others	74	Most powerfull locomotive in SNCF service
	BB-22200	25 kV a.c./ 1500 V d.c. electric	locomotive	180 km/h	1973 to present	n/a	150	
	BB-15000	25 kV a.c. electric	locomotive	180 km/h	1971	n/a	48	
	BB-7200	25 kV a.c. electric	locomotive	180 km/h	1973 to present	n/a	110	
	CORAIL VTU 75	-	Domestic-service coach	200 km/h	1975 to present	Almost all mainline intercity	1830 plus	Air-conditioned, well insulated
	CORAIL VU75	-	International service coach	200 km/h	1978 to present	International service	800 plus	As above
	RTG TURBO-TRAIN (Figure 3.15)	Gas turbine (2 power cars per trainset)	5-car articulated trainset for bidirectional operation	200 km/h	1974-1977	Secondary intercity lines	70 trainsets	Also in use in U.S. and Iran
West Germany	ET403 (Figure 3.16)	Electric	4-car articulated set, two power cars, bidirectional operation	200 km/h	1976-77	Bremen-Munich	3	Further orders not contemplated -- both initial cost and maintenance are higher than for conventional high-speed electric locomotives
	Class 103	Electric 6200/7200 kW, 15 kV a.c. power	locomotive	200-250 km/h	1965-70	High-speed intercity service (Hamburg-Koln-Munich-Hanover; Hamburg-Basel; Bremen-Wurzburg-Munich)	55	-
	Intercity Coaches	-	Both new and refurbished coaches are used on intercity 200 km/h services. The new units are all air-conditioned; older second-class coaches are not all so equipped	200 km/h	n/a	all	n/a	-

TABLE 3.2(b)

CURRENT PASSENGER ROLLING STOCK - WESTERN EUROPE AND JAPAN

	Current Technology							
Country	Designation	Propulsion	Design Speed	Speed	When Built	Routings	Fleet Size	Other Features/Comments
Italy	Fiat "Pendulino" (ETR-401) (Figure 3.17)	Electric	4-car bi-directional trainset	250 km/h	1975	Rome-Ancona	1 set	Blocked by a combination of electrical problems and communist trade unions, which refused to run service with first-class supplement. Passenger acceptance was very high (load factor 80%+). Train used gyroscopic tilting mechanism.
Spain	"TALGO" (Figue 3.18)	Locomotive-hauled, usually by diesel units	Articulated trainset; single-axle wheelsets between cars. Wheels rotate independently.	200 km/h design, 180 km/h current limit	1974-80	Madrid-Barcelona; Bilbao-Orviedo-Valencia-Corumma; Valencia-Barcelona; Madrid-Paris (1981)	132 day coaches; 56 sleepers and generator cars	Passive body-tilting mechanism allows operation at high speeds on curved track. Body is made of lightweight aluminum extrusions. On-board power is provided by special 130 kW generator cars feeding commercially-available 380/220 V, 50 Hz, three-phase electric motors
Japan	Shinkansen (Figue 3.12)	25 kV, 60 Hz a.c. electric power, 740 kW/trainset	16-car articulated trainset, 1500 seats, suited for bi-directional operation	210 km/h	1964	Tokyo-Hakata (1,069 km)	2,336 cars	Steel construction for vehicles; part of high-spued system including completely grade-separated track, full CTC and Automatic Train Control. Densities of ten 16-car trains per hour each way are regularly run. The Shinkansen system is highly profitable, and has been since its second year of operation.

TABLE 3.3

NEAR-FUTURE RAIL PASSENGER ROLLING STOCK

Country	Current Technology					
	Designation	Propulsion	Configuration	Design Speed	Scheduled Start	Other Features
Canada	LRC (Figure 3.4)	Diesel-electric (3700 hp) trainset -- 16 cycle MLW/ Alco 251 engine	Power car plus 5 coaches (can also run as 1-10-1)	200 km/h	Late 1981/82	LRC has power tilting body design to allow operation at speed over tight curves. However, the locomotive axle-loading has climbed from 20.4 tonnes to 25.3 tonnes (both well above the 17 tonne limit imposed by British Rail in its HST and APT units), so there is considerable doubt that the design speed can be achieved without unacceptable levels of damage to the track. Consequently, the LRC really does not represent any great advance in terms of capability over the existing VIA equipment. Twenty-two power cars and 50 coaches are on order for VIA; 2 power cars and 10 coaches for AMTRAK.
United States	AEM-7 (EMD/ASEA) (Figure 3.9)	Electric; 11 kV, 25 Hz/12.5 kV, 50 Hz; rated at 4,250 kW	locomotive	200 km/h	Deliveries now to June 1981 for 30 units; a further 17 are on order	Will be used in Northeast Corridor to handle six-coach Amfleet consists between New York and Washington. Cost was approx. $3.0 million/unit in $1980 U.S.
	Long-distance Amfleet coach	-	60 seat, single-level coach; food service car in same body shell	200 km/h	late 1982/83	Designed for service in Eastern U.S.; standard Amcoach carbodies used; order is for 125 coaches, 25 food service cars. Additional order for sleepers and diners is expected in fiscal 1981.
Britain	APT (Advanced Passenger Train) (Figure 3.6)	Electric 25 kV 50 Hz a.c. power	Articulated active tilting body trainset in either 1-11, 1-12-1 or 1-14-1 consists, with 1-12-1 "standard" for bi-directional operation.	250 km/h	Demonstration service on London-Glasgow mainline to have begun in May 1980 at 200 km/h	250 km/h will require in-cab signalling, which is not as yet in place. Current plans call for about 70 trainsets to be delivered by 1986. Unpowered bogies are steerable to reduce flange contact.
France	TGV (Figure 3.11)	Electric; 25 kV, 50 Hz, a.c./1.5 kV d.c. dual system traction. Two power cars per trainset.	Ten-car articulated trainset; no body tilting	300 km/h operations will have 260 km/h max. and 220 km/h min., including turnouts	October 1981 on all new Paris-Sud-Est line, with feeders to Marseilles, Genoble, Begiers, Lausanne, Geneva	Producton of 115 TGV trainsets planned. Axle loads are less than 17 tonnes. Can have either 240 second-class seats plus 135 first-class seats or 275 plus 111.
Soviet Union	ER200 (Figure 3.12)	Electric, six two-car power sets per consist (10,320 kW)	14-car consist, 816 seats, head-end cars are unpowered; 1-2-2-2-2-2-2-1 consist design	200 km/h	n/a	Built at Riga works in Latvian SSR. First shown July 1977, but has never been put into production, allegedly due to suspension problems resulting in track damage, although axle load is low (17 tonnes).
Japan	Type 961 (Figure 3.13)	Electric 25 kV a.c., 50/60 Hz (1100 kW/car)	16-car fixed consist, bi-directional trainsets	260 km/h	Late 1981/82 (on completion of Tohoken and Joctsu Shinkansen lines)	Aluminum construction for car bodies; 16 tonnes axle load.

operation on low-density routes. These vehicles, which can be run singly[8] or in multiple unit combinations, are capable of bi-directional operation without the need for slow, costly turning at terminals. This permits very rapid reversing departures[9] thereby increasing vehicle utilization and flexibility. Typically, these vehicles can be operated with smaller crews than are acceptable on conventional passenger trains, and consume less fuel than a large diesel locomotive. The twin-engine design of many units provides a significant improvement in "get-home" capability -- a major consideration for winter operations in Northern Ontario. Consequently, economic operation of SPV units is possible on routes with traffic densities too low to support conventional passenger trains.

At present, rail service to northern Ontario communities located on the CN lines between Winnipeg and Cochrane, Nakina and Sudbury, and Sioux Lookout and Thunder Bay is provided by a combination of mixed freight and passenger trains and short-consist locomotive-hauled equipment. Similar services are operated between Hearst and Sault Ste. Marie over Algoma Central tracks and between Cochrane and Moosonee on the Ontario Northland. With the exception of the overnight train between Sudbury and Winnipeg (and the Transcontinental service on the CP line through Sudbury, Thunder Bay and Kenora), these operations are candidates for use of self-propelled vehicles, although the marginal cost position of the passenger service in mixed trains makes this substitution less attractive economically. However, the opportunity to upgrade service quality, through provision of a small galley, enhances the position of the RDC type vehicles even on the mixed runs. Vehicles suitable for use in Northern Ontario must offer a very high degree of reliability, a substantial level of passenger comfort -- all existing routes take upwards of five and a half hours with on-time operation -- and the ability to tolerate rough track conditions with numerous curves. Speed is not a consideration; existing services average less than 40 mph.

These requirements militate against the use of single engined vehicles such as the BR-Leyland "rail bus" or the Hawker-Siddeley RTC-SPD (Figure 3.22). The extra operating reliability provided by two engines is significant, as is the potential for dual heating systems, such as the hot-water heating now used in the RDC. The heating system should be capable of maintaining comfortable interior temperatures under ambient conditions of at least -40°C while the vehicle is in operation. This is possible with the existing RDC system,

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8 In some locations two RDC's must be operated together because a single unit may fail to activate track signals.

9 RDC units on the Montreal Lakeshore service run reversing departures as little as 11 mintues after arrival.

Figure 3.21   Budd Rail Diesel Car (RDC)

(Jeff Young)

Figure 3.22   Hawker-Siddeley TRC-SPD

although improvements in vehicle insulation, weatherstripping and the design of the operator's compartment would be necessary.

The characteristics of a representative selection of self-propelled vehicles which are either currently in use or in the late stages of development are given in Table 3.4.

Table 3.5 summarizes estimated direct operating costs per consist-mile for RDC-type units, equivalent-capacity locomotive-hauled consists, and equivalent-capacity mixed-train operations for three Northern Ontario routes now served by VIA Rail. An RDC-type unit would enjoy a substantial advantage over the locomotive-hauled consist now serving the Capreol-Nakina route -- over $1 million per year -- but would be more costly than the mixed-train services on the Nakina-Hearst and Thunder Bay-Sioux Lookout runs. However, the costs estimated for the latter services are the marginal costs associated with operating the rolling stock. No allocation of train costs is included, so that the actual price charged for the service will likely be higher than this marginal cost. This would make the use of an SPV more attractive.

3.1.5 Long-Term Changes in Passenger Technology

Over the next five to ten years, many incremental changes will occur to passenger rolling stock, principally through the implementation of state-of-the-art technology now in the design and testing stages. Such refinements as steerable trucks fall into this category.

Over longer periods, the possibility of introducing radical technological state changes must be considered. In the Canadian market, construction of an electrified high-speed passenger system[10] -- analogous to that now being built in France between Paris and Lyons -- would fit this description, as, indeed, would electrification of portions of the existing rail network. Still more radical would be a departure from traditional steel-wheel-on-steel-rail technology in favour of a magnetically-levitated (Maglev) vehicle capable of speeds of 450 to 500 km/h. A study carried out by CIGGT for Transport Canada Research and Development Centre and now in the final stages of preparation,[11] has shown that under some circumstances, such a system serving a Toronto-Ottawa-Montreal rout-

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10 "Alternatives to Air: A Feasible Concept for the Toronto-Ottawa-Montreal Corridor," CIGGT Report No. 80-4, July 1980 (in preparation).

11 "Alteratives to Air: A Feasible Concept for the Toronto-Ottawa-Montreal Corridor," CIGGT Report No. 80-4, July 1980 (in preparation)

TABLE 3.4

COMPARISON OF SELF-PROPELLED VEHICLES

Vehicle	Budd§ RDC (U.S.) (Figure 3.21)	Budd††,** SPV-2000 (U.S.) (Figure 3.23)	Hawker-Siddeley§ RTC-SPD (Canada) (Figure 3.22)	Commonwealth† Engineering (Australia)	British Rail* Diesel Multiple Unit (England)	British Rail* Leyland "Railbus" (England)*	Italy	
							Fiat RDC§ (for Italian State Railway)	Fiat ALn 688†† (for Swedish State Railway)
Type	Multipurpose RDC	Multipurpose RDC	Commuter	Commuter; some diesel-electric powered, some trailer.	2-car DMU, 2-axles/car.	single unit railbus, 2 axles	Secondary service RDC	Suburban/ commuter
Speed	80 mph	100 mph; up to 120 with modifications	80 mph	75 mph	75 mph	75 mph	60 mph	80 mph
Seating	72 coach 60 coach/snack bar	Intercity 86, 2+2; Branch, 60 + baggage, 2+2; Commuter 109, 3+2	94 commuter standards	72 power runs, 106 trailers, 3+2 seating	250/car, 100 per set	approx. 40	68	76, 2+2
Power Plant	2 x GM6-110 Diesel (original equipment)	2 x 360 hp GM truck diesel 8V-92	1 x 350 hp Rolls-Royce diesel	2 x 12 cycle diesels, with 500 hp each,	2 x 200 hp Leyland truck diesel	1 x 200 hp Leyland truck diesel	250 hp Fiat diesel	2 x 450 hp IVECO diesels 8217.12.150 truck
Dimensions	-	24 m x 4.3 m x 3.2 m	-	25.5 m x 4.3 m x 3.2 m	16 m x 2.5 m wide	12 m long	22.7 m	24 m x 37 m high x 3.2 m wide
Body	Stainless steel	800,000 lb composition stainless steel	Meets AAR standards	Stainless steel	Modified Leyland bus body--does not meet AAR compression	Leyland bus body--does not meet AAR compression	330,000 lb compression	330,000 lb compression
Other Features	Some have snack bars	High-speed nose available Diesels fitted for cold weather starts	Double cabs	Air-conditioned				Insulated and heated for up to -40°C. Toilet on board.
Cost	No longer in production	$850,000 ($1980 U.S.)	$800,000 ($1976 Cdn)	n/a	n/a	$450,000 ($1980 U.S.) approx.	$400,000 ($1976 U.S.) approx.	$400,000 $1978 U.S.) approx.
Crew	2 (single unit)	1 or 2	1 or 2	2	1	1	n/a	1
Availability	Now in service	On order	In production (?)	In production	Experimental (1980)	Experimental (1980)	In production (1976)	In production (1978)

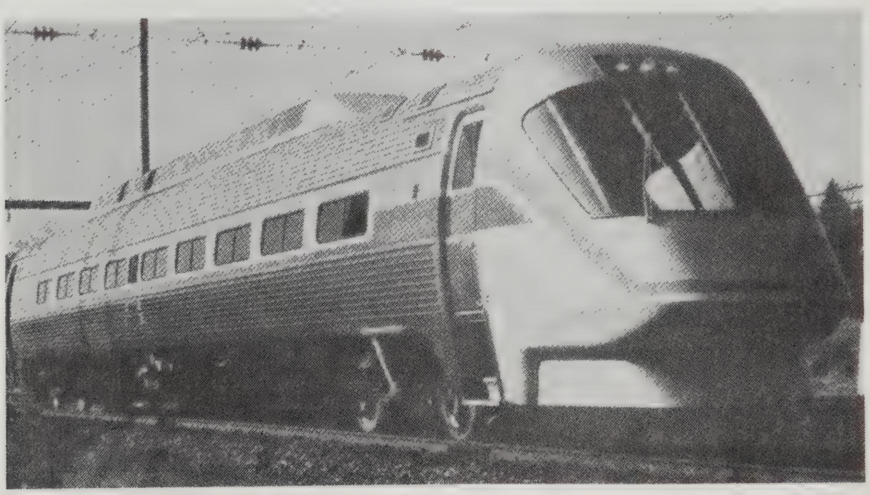
§ "Budd RDC Modernization Study," CPCS Ltd, December 1976.
* International Railway Journal, December 1979, and March 1980.
† Railway Gazette International, September 1979.
†† Railway Gazette International, March 1978.
** Progressive Railroading, March 1978.

TABLE 3.5

COMPARISON OF DIRECT OPERATING COSTS FOR SPV, LOCOMOTIVE-HAULED AND MIXED TRAIN PASSENGER SERVICE ON SELECTED NORTHERN ONTARIO ROUTINGS

	Capreol-Nakina 428 miles x 312 trains/year for 133,536 consist-miles/year	Nakina-Hearst 144 miles x 312 trains/year for 44,928 consist-miles/year	Thunder Bay- Sioux Lookout 202 miles x 372 trains/year for 75,144 consist-miles/year
Mixed-Train Costs:			
1 Coach	n.a.	1.436 x 44,928 = 64,517*	1.436 x 75,144 = 107,907
2 Coaches	n.a.	2.872 x 44,928 = 129,033	2.872 x 75,144 = 215,814
1 Coach plus 1 Dinette/Cafe	n.a.	4.33 x 44,928 = 217,158	4.833 x 75,144 = 363,171
Locomotive-Hauled Passenger Train Costs:			
1 Locomotive + 1 Coach	$10.968 x 133,536 = $1,464,623*	n.a.	n.a.
1 Locomotive + 2 Coaches	$11.792 x 133,536 = $1,574,657	n.a.	n.a.
1 Locomotive, 1 Coach and 1 Dinette/Cafe	$13,658 x 133,536 = $1,823,835	n.a.	n.a.
1 Locomotive, 2 Coaches and 1 Dinette/Cafe	$15,088 x 133,536 = $2,014,790	n.a.	n.a.
RDC-Type Units:			
Single Unit, Coach	$3,153 x 133,536 = $ 421,039	1.436 x 44,928 = $141,658	1.436 x 75,144 = $236,929
Double Unit, Coach	$6.943 x 133,536 = $ 927,140	2.872 x 44,928 = $311,935	2.872 x 75,144 = $521,724
Single Unit, Coach-Galley type	$5.702 x 133.536 = $ 761,182	4.833 x 44,928 = $256,179	4.833 x 75,144 = $428,471
Double Unit, 1 Coach plus 1 Coach-Galley	$7.946 x 133.536 = $1,061,077	6.269 x 44,928 = $356,998	6.269 x 75,144 = $597,094

* indicates existing service type



(Railway Gazette International)

Figure 3.23 Budd SPV-2000 (with high-speed nose)

ing could be economically attractive.[12] A great deal of additional technical development remains to be done before such a Canadian Maglev system could be built; the earliest operation date is essentially to be 1995, with 2000 a more realistic possibility. Both Germany and Japan are more advanced in the development of an operating Maglev vehicle. The quarter-scale test model built by Japanese National Railways has reached speeds in excess of 500 km/h, and plans are now current to proceed with full-scale prototype development. A 1990 target date for revenue operation has been suggested by JNR project leaders. Work in Germany is less advanced, but the development, testing and evolution of critical components is proceeding.

Air cushion vehicle (ACV) technology sparked considerable interest in the 1960's as a basis for high-speed ground transportation, but unfavourable economics, noise and high energy use resulted in development work being discontinued around 1974.

3.2 Freight Rolling Stock

At the present time, the characteristics of North American freight rolling stock and those of rolling stock in service on the railways of Western Europe, Asia and Africa, differ appreciably. Only the Soviet Union shows some degree of similarity with North America in terms of its approach to freight operations and hence to the design of rolling stock.

These differences have arisen in part from the differing economies of operation between Europe (where electrified traction predominates on main lines, and, until recently, almost all classification operations were carried out in flat yards) and North America (with diesel-electric locomotives and hump-yard classification). In particular, the "humping" process necessitates a more heavily constructed, robust car. European freight "wagons" are becoming larger (and heavier), but the predominant position of high-speed passenger service on European lines imposes an upper limit on axle loadings of about 20 tonnes. In each case, the car designs are well adapted to the primary orientation of the operating companies -- freight in North America, passengers in Europe.

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12 The Maglev system is not as attractive as a high-speed electrified railway, although there are significant differences in timing (1995 for Maglev, 1986 for high-speed rail). However, the economic attractiveness of any high-speed ground mode hinges on its ability to capture an adequate market share. The CIGGT demand scenarios are contingent on the world market petroleum price in Canada, with sustained (but reducing) real growth in this price over the period of analysis.

3.2.1 North American Rolling Stock

North American freight operations over the past decade have been characterized by a steady increase in the size of individual cars -- bulk commodity cars capable of carrying 100 tons of lading (263,000 lb gross weight) are now common. The number of cars per train, and thus the trailing weight of the consist, has increased -- 12,000 to 15,000 ton freights are routinely operated -- and, in many cases, so has the speed of operation. This period has also seen a major growth in the use of solid or unit trains (dedicated consists carrying a single bulk commodity such as coal, between, typically, one origin and one destination), and in truck trailer and container traffic. These developments represent one of the efforts by the operating companies to overcome the effect of continually increasing labour and material costs through increased transportation productivity. Of necessity, the size and complexity of cars and locomotives has also increased.

This growth in car capacity is well illustrated by the fact that the capacity of the average hopper car in use by CN and CP increased from 68 tons in 1962, to over 93 tons by 1980. This growth is the result of scrapping older, lower-capacity units in favour of modern 100-ton cars, such as the open-top "bath tub" coal car developed by CP Rail or the covered grain hopper developed jointed by CP, CN and Transport Canada.

One of the most promising changes in the design of freight cars is the development of an articulated truck. Since railway car wheels are fixed rigidly to solid steel axles, neither wheel can rotate independently or at a different rate from the other. This, combined with the fact that conventional construction is such that the axles cannot align themselves radially when negotiating a curve, results in high contact pressures between the wheel flange and the rail causing excessive wear to both, other track damage, and occasionally, derailment. To overcome these deficiencies, an articulated truck, allowing the axles to align themselves radically to the curve, has been developed through joint Canadian and United States effort. The primary benefit will be little or low flange contact in curves. A secondary, but important, benefit will be improved stability on tangent track of vehicles in high-speed/light-load freight and express service. The instability experienced with conventional trucks in such service, commonly referred to as "truck hunting" leads in some cases to lading damage and excessive wear of track components. There are also fuel savings.

Several hundred of these new trucks are now in test service throughout North America. Conventional trucks can be retrofitted. It has been estimated that a gross return on investment of 50 per cent per annum might be expected in territories carrying large numbers of 100-ton cars. A further major benefit will be

increased reliability of service due to reduction of track and vehicle failures resulting from wear and other damage.

Although the steerable truck is probably the most promising near-future technological innovation, it is by no means the only one. There are several, such as the Bi-modal Corporation's RoadRailer, which will have a considerable effect on the competitiveness of intermodal freight; these are discussed and illustrated in Section 3.2.4. The reduction of tare weight through the use of aluminum or light alloy car bodies is also under active consideration.

In the longer term, conventional freight rolling stock -- box cars and flat cars especially -- may be replaced by containers (or anaologous pallet-type decks) and standardized underframe/wheelset units. Canadian Pacific has indicated that this is one of their long-term objectives. This system would permit increased utilization of the components essential for movement -- the load-bearing frame and trucks -- without reducing the availability of the load-carrying components -- the container "box" or "flat" -- to the shipper. It would necessitate specialized equipment to load/unload the detachable components. The degree of standardization required should offer substantial economies of scale (in terms of long production runs), thereby reducing the capital cost of conversion, while tare weight reduction should be possible in the underframe (as with the "Ten Pak" cars -- see Section 3.2.4), and this, in turn, would yield operating cost savings, especially fuel savings.

3.2.2 North American Motive Power

Diesel locomotives have also undergone increases, in both size and power. In the early 1960's, after dieselization was completed, a typical road unit would be rated at 1500 hp. Today, 3000 to 3600 hp units are commonly purchased for road service, although locomotives with less power are still available, as shown in Table 3.6.

Without any question, intensive efforts towards increased fuel efficiency for diesel-electric motive power could be the most pronounced trend in freight over the next decade. Railway electrification with its petroleum savings faces economic complications in Canada, where the institutional structure makes it difficult for the railways to ensure capture of sufficient of the cost savings benefits to make the large capital outlay attractive as an investment. However, ultimate electrification of main lines appears inevitable.

Improvements in fuel efficiency will be derived from several sources. First, the widespread application of sophisticated electronic wheelslip control systems, such as the Positive Traction Control (PTC) developed by CN Rail Research, will improve the usable tractive force which can be produced per

TABLE 3.6

CURRENT PRODUCTION - NORTH AMERICAN ROAD FREIGHT LOCOMOTIVES

Locomotive model			Wheel arrangement*	Engine				Turbo-charger model	Electrical components			Truck type (standard)	Locomotive wgt.(service,lb.)		Standard features	Examples of available optional items	Notes
Bombardier, Inc.	Electro-motive	General Electric		hp for traction	Cylinders	Full-load rpm	Model		Generator model	Traction motors Model	Traction motors Connection		Min.	Max.			
	GP-15-1		B-B	1.500	12	900	645 E	Normally aspirated	D-32	D-77	Series-parallel	GP-type	240.000	—		Low idle	Available on trade-in only
		B-18-7	B-B	1 800	8	1 050	FDL	Elliott	GTA-11	752 E8	Series parallel	F-B	230 600	268 000	83 20 gearing	Low idle	
	GP-38-2		B-B	2 000	16	900	645 E	Normally aspirated	AR-10	D-77	Parallel	GP-type	250 000	277 500		Low idle	SD-39 6-axle equivalent available
		B-23-7	B-B	2 250	12	1 050	FDL	1412 A1	GTA-11	752 E8	Series parallel	F-B	253 000	280.000		Low idle	C-23-7 6-axle equivalent available
	GP-39-2		B-B	2.300	12	900	645 E3B	E-3B	AR-11	D-77	Parallel	GP-type	250.000	277 500		Low idle	
HR 412			B-B	2 400	12	1.000	251 E	165	GTA-17	752 E8	Series-parallel	ZWT	240 000	272 000	Micro-limit slip detection	500 kW head-end power full-width carbody	First deliveries 1981
	GP-39X		B-B	2 700	12	950	645 F3	F-3	AR-15	D-87	Parallel	GP-type	n a	n a.	Super-Series wheel creep control. 70·17 gearing	.	"GP-49" prototypes delivery late 1980
		B-28-7	B-B	2 750	12	1.050	FDL	1412 B1	GTA-11	752 E8	Series parallel	F-B	253 000	280 000	83 20 gearing	Low idle	
		C-28-7	C-C	2 750	12	1 050	FDL	1412 B1	GTA-11	752 E8	Series-parallel	F-B	359.000	420.000	83 20 gearing	Low idle	
	GP-40-2		B-B	3 000	16	900	645 E3B	E-3B	AR-10	D-77	Parallel	GP-type	256 000	277 500		Low idle	
		B-30-7	C-C	3 000	16	1.050	FDL	1616 B2	GTA-11	752 E8	Series-parallel	F-B	259 000	280 000	83 20 gearing	752 AF motors Low idle	
	SD-40-2		C-C	3 000	16	900	645 E3B	E-3B	AR-10	D 77	Series-parallel	HT-C	368.000	420 000		Low idle	
		C-30-7	C-C	3 000	16	1 050	FDL	1616 B2	GTA-11	752 E8	Series-parallel	F-B	366 000	420.000	83 20 gearing	752 AF motors Low idle	
HR 416			B-B	3 200	16	1 000	251 E	165	GTA-11	752 PC8	Series-parallel	ZWT	255 000	280 000	Micro-Limit slip detection	500 kW head end power Full-width carbody	First Deliveries 1981
HR 616			C-C	3 200	16	1 000	251 E	165	GTA-11	752 PC8	Series-parallel	Hi-Ad	380.000	420.000	Micro-Limit slip detection	Full-width carbody	First deliveries 1981
	GP-50		B-B	3 500	16	950	645 F3	F-3	AR-15	D-87	Parallel	GP-type	260 000	277 500	Super-Series wheel creep control 70 17 gearing	HT-B Trucks	First production-unit deliveries 4/80
	SD-40X		C-C	3.500	16	950	645 F3	F-3	AR-16	D-87	Parallel	HT-C	368.000	n a	Super-Series wheel creep control 70 17 gearing		"SD-50" prototypes. production units 1981
		B-36-7	B-B	3 600	16	1 050	FDL	1616 B2	GTA-24 Parallel/ series	752 AF	Parallel	F-B	260.000	280.000	Sentry Adhesion Control 83 20 gearing	Low idle	First deliveries 10/80
		C-36-7	C-C	3.600	16	1.050	FDL	1616 B2	GTA-24 parallel/ series	752AF	Parallel	F-B	366.000	420.000	Sentry Adhesion Control 83 20 gearing	Low idle	
HR 618			C-C	3.600	18	1 000	251 E	165	GTA-11	752 PC8	Series-parallel	Hi-Ad	388.000	420 000	Micro-Limit slip detection	Full-width carbody	First deliveries 1981

All Bombardier and General Electric engines are 4-stroke cycle; all Electro-Motive engines are 2-stroke cycle.

Truck designations: GP-type = EMD swing-hanger. F-B = GE floating bolster. ZWT = MLW zero weight transfer. HT-C = EMD high-traction

(Railway Age, 14 April 1980)

* Wheel arrangements for North American diesel-electric locomotives are classified internationally by a letter system. Two powered axles in one solid frame truck are given the letter "B". Three powered axles in one truck are given the letter "C". Hence, a 6P-40-2, which has two trucks of two axles, is referred to as a "B-B" locomotive. Likewise, a SD-40-2 which has two trucks of three powered axles each is referred to as a "C-C" locomotive.

gallon of oil consumed by a given locomotive. The PTC can provide increases in usable tractive effort of 15 to 20 per cent under most service conditions, and is already in use on 400 four-axle CN locomotives; a further 300 six-axle units are to be retrofitted over the next three to five years. A license has been granted to Vapor Corp., Chicago, to manufacture and market PTC worldwide. The anticipated market is 1000 units a year in the 1980's.

Improvements in engine design and operating procedures will further increase fuel efficiency. Engine components will be lighter, simpler and more reliable, the loads imposed by auxiliary equipment will be reduced -- almost 70 per cent of the improvement in fuel consumption claimed for the Bombardier/MLW HRC16 comes from this load reduction -- and provision will be made for lower idle speeds and field shutdown and restart.[13] Improved operating procedures -- running the minimum number of engines in a multiple-unit consist needed to maintain speed at full power while keeping the other units at idle, for example -- can offer significant savings. These "fuel-saver" procedures can be fully automated, using microprocessor technology, or can be implemented manually.

A third source of improved fuel efficiency may come from the introduction of four-stroke (Sulzer) diesel engines in place of the standard two-stroke North American units. A number of 1500 hp Sulzer-engined units have been built by Morrison-Knudsen and are being tested operationally on the Southern Pacific. Fuel savings of 11 to 16 per cent over conventional units of equivalent horsepower were obtained. In a similar approach to the problem, small yard locomotives have been equipped with a pair of four-stroke, turbocharged industrial diesels, mass-produced for other applications. These 136-ton locomotives can operate on one or both engines, have 42 per cent lower fuel consumption at twin-engine idle, and can be shut down and restarted easily in cold weather. The large number of these diesels in industrial and construction use means that parts and servicing are readily available on a nation-wide basis, even in remote areas.

In the longer term, savings in diesel fuel use (on the order of 10 per cent) may be achieved through use of "bottoming" cycle attachments which would recover as useful work the diesel engine's exhaust heat. In the much longer term (certainly beyond the year 2000) major engine developments resulting in further savings are possible.

The United States and Canada are cooperatively pursuing programs to assess alternative fuels for use in diesel locomotives (the Alternative Fuels for

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13 In the past, diesel locomotive engines were kept running at all times, except under shop conditions. This prevents problems with restarting, and also eliminates the possibility of water accumulation in the cylinder head during shutdown, a condition which can result in broken or bent connecting rods. However, it is an increasingly expensive safeguard. Current practice on CP and CN is to keep diesel locomotive engines running at temperatures below 45-50°F (7-10°C).

Medium Speed Diesel Engines research program was initiated in 1978). It is possible to produce a suitable diesel fuel from a variety of hydrocarbon sources (including tar sands, oil shale, coal), and as world oil prices continue to rise, such substitutions may become more attractive. However, it is not clear that an exact replication of the Diesel No. 2 specification will be practical and economic in the context of a petroleum production process serving a broad spectrum of fuel requirements, including automotive, aviation, trucking, home heating, and petrochemical uses. In the near term the likely approach (beyond improvements in engine efficiency and other conservation measures) is introduction of a broader diesel fuel specification. Engine testing by Southwest Research Institute suggests that this may be practical, although the need for testing under cold weather conditions is an important qualification. Also the impact of broader fuel specifications on locomotive maintenance is not well known.

Although the basic diesel engine design could be modified to burn a wide variety of fuels, considerable development engineering would be necessary. Given the long time frame for the introduction of major new fuels, this development effort is unlikely unless there is greater certainty about the nature, availability and price of proposed new fuels. The problem is further complicated by the longevity of railway equipment (typically thirty years or more), which makes the rapid acceptance of new fuel/technology combinations unlikely in other than emergency situations. In the shorter term (certainly up to the year 2000), the only practical form of alternative energy is electricity, which can be generated from a variety of energy sources, including those indigenous to Ontario.

3.2.3 Europe

Since many of the countries of Western Europe are served by well-developed systems of inland waterways and canals, which have traditionally handled the movement of heavy bulk commodities, European rail freight operations differ substantially from those of North America.[14] The heavy emphasis placed on frequent high-speed passenger service has further reinforced this fundamental difference, with most nations enforcing a 20-tonne axle-load limit (British Rail allows 25 tonnes per axle).[15] Freight trains are much shorter and lighter than those in North America, operate more frequently, and run at higher speeds, especially those carried on electrified trackage. Express freights in West Germany are

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14 Britain is something of an exception. Almost 92 per cent of the rail freight-tonnage moved in 1978 was bulk materials (coal, coke, iron, steel, minerals, chemicals).

15 A 263,000 lb gross weight four-axle car has an axle load of almost 30 tonnes.

limited to 1,500 tonnes trailing weight and/or 60 cars, but can operate at speeds of up to 120 km/h. Even the Soviet Union, which more closely parallels the U.S. and Canada in its rail freight operations, limits bulk commodity trains to 5,000 tonnes trailing weight and 25 tonne axle loads. This type of freight operation is much more compatible with operation of quality passenger service than is the North American freight operation.

3.2.4 Piggyback and Containers

The greatest commonality in freight rolling stock between Europe and North America occurs with equipment designed to handle truck trailers (piggyback) (Figure 3.24) and containers (Figure 3.25). Both continents have experienced a rapid growth in such traffic since 1975, although most of the increase in North America has been in the movement of road trailers, while that in Europe has come in container movements. Container and trailer traffic in the U.S. increased an average of 12 per cent annually from 1975 to 1979, while West Germany expects that traffic to double by 1985. These real and anticipated increases have led to the introduction of a number of innovations, both here and in Europe.

One which is already in service is the articulated flat car system (Ten-Pak) introduced by the Santa Fe Railroad for long-distance piggyback service (Figure 3.26). Their reduced weight and increased capacity has reduced fuel consumption for a train of such cars carrying 100 trailers between Los Angeles and Chicago by about 5,000 gallons per round trip. Another similar development is the four-axle tandem unit designed by Trailer-Train which is expected to undergo service testing in 1980.

A number of other ideas will be tested in the near future. Paton Corporation has designed an articulated TOFC trainset, similar to the "Ten-Pak," but capable of easy disassembly for consist rearrangement or emergency service. The U.S. Federal Railroad Administration is funding development of a low-profile intermodal car to meet the height restrictions on tunnels in the Northeast Corridor, while interest in "roll-on/roll-off" facilities has been regenerated. Perhaps the most radical change is the RoadRailer (Figure 3.27), a conventional 45-foot road trailer equipped with a rail coupler and single railway wheel-set to replace its highway wheels. These units, which will enter limited service in late 1980 or early 1981, can be run in trains of up to 75 units, and are compatible with conventional rolling stock.

The development of advanced container cars in North America has received less emphasis than has been placed on new "Piggyback" equipment, but Southern Pacific Railway is testing a new articulated triple-unit, double-stack container car, supported on four two-axle trucks, which weighs half as much as conventional flatcars with equivalent capacity.

(Jeff Young)

Figure 3.24 Trailer on flat car (TOFC or Piggyback)

(Railway Gazette International, July 1978)

Figure 3.25 Container on flat car (COFC)

(Railway Gazette International)

Figure 3.26

Low tare weight "Ten Pak" cars designed by Santa Fe especially for "piggyback" operations. Note skeletal structure in top picture. The use of overhead crane is typical of high-productivity intermodal yards

Figure 3.27

The Bi-Modal Corporation RoadRailer, seen here undergoing tests on the Florida East Coast Mainline, can run at speeds of up to 160 km/h in conventional trains. Either set of wheels can be raised or lowered by inflating or venting sets of air springs. Prototype RoadRailers are 13.7 m long and 4.1 m high; their reduced weight and air resistance compared to conventional piggyback is expected to cut fuel consumption by 44 per cent

(Railway Age, July 30, 1979)

However, as has been discussed in Section 2.2.3 of this report, the major changes in intermodal services will come in operating practices and yard procedures, rather than in railway "hardware."

4. TRACK

4.1 Influence of Track on Railway Service Levels and Productivity

The major objective in railway location is to select the route that will give the most economical combination of construction costs and operating expense. Although gradients and curvature increase operating expense, their elimination is costly, and economic trade-offs during the design and construction period are necessary. As a result gradients and curvatures abound throughout much of the Canadian rail system, presenting significant service level and productivity constraints. Curvature limits speed -- an important consideration for passenger services -- and leads to high track and rolling stock maintenance costs, particularly rail and wheel wear. Gradients increase the requirement for locomotive horsepower and cause additional fuel consumption and brake, wheel and track wear. Where curvature and gradients are severe, operating costs can be reduced and train performance improved through relocation of the line, but as the attempts to reconfigure nature are increased, cost increases sharply. When the penalties imposed by alignment grow with traffic, the economic balance will shift to favour upgrading, but this is an expensive, very long-term decision.

Freight traffic is growing steadily on some portions of the system, to the extent that CP Rail is undertaking reduction in gradient of portions of their main track through the Rocky Mountains. During the middle 1960's, a program of curvature improvements was carried out by CN Rail on their Montreal-Toronto line, in preparation for their now well-established and, by North American standards, successful, Rapido and Turbo passenger train operations. As the Canadian population continues to expand and the cost of fuel escalates, the demand on the railway system will increase, and more such projects will become economically viable.

Curvature and gradient do not constitute the only physical impediments to improved productivity. The necessity to run trains in both directions on a single track route is a major limiting factor. Unless trains meet at the designated passing tracks with perfect timing, delays result. The addition of an extra train to handle increased traffic creates one additional meet to all opposing trains. With each meet, the running time of each train is extended, further increasing the probability of additional meets, thus producing a compounding delay effect. As traffic grows, investment in measures to reduce or

eliminate these delays (additional passing tracks, improved signals, and ultimately a second track) become economic.

A number of other factors can affect productive capacity. These include locomotive and car ownership, terminal facilities, signal and communications systems, operating procedures, maintenance level, manpower skill level, union work rule constraints and weather. In some cases, extensive prior research and development effort is needed to capture the benefit achievable by investment or other change to these factors. Encouraged by favourable traffic forecasts and spurred by the need for improved effectiveness, Canada's railways are devoting substantial efforts to research and development. Since the early 1950's, major operational improvements have been made and particularly in recent years, it has been recognized that these and future improvements are desirable in the interests of maintaining the continued economic growth of the nation.

4.2 Track Design

There are four principal components to railway track structure, viz. rail, ties, ballast and subgrade. Each component has a particular function to perform and the four together provide support for the locomotives and cars.

The characteristics of the traffic to be carried form the principal basis for selection of rail and fastenings, ties and ballast. The most important traffic characteristics are annual gross tonnage, train speed and number of heavy vehicles (such as 100-ton cars).

Maximum stresses in the various track components are a function of wheel load, tie dimensions and spacing, ballast and subgrade properties, and wheel/rail profile geometry. The dynamic (moving) wheel load, which is greater than the static (stationary) load, is a function of static load, speed, track structure and stiffness and track irregularities. The highest dynamic wheel loads are generally imparted by conventional diesel locomotives because of the unsprung weight of their axle-mounted traction motors. Additional loads are introduced into the track structure by the starting and braking of the vehicle and as a result of temperature changes. Lateral forces are imparted into the track by vehicles negotiating a curve and by lateral motions of the vehicle truck even while traversing straight track (truck hunting).

The load which the track is able to carry depends on:

- the carrying capacity of the rail as a beam between the ties, and the stress at the contact point between wheel and rail

- the ability of the fastenings to transmit the loads from the rail to the ties
- the ability of the ties to spread the load evenly over the ballast
- the ability of the ballast and subgrade to withstand the pressures from the ties.

In the selection of track components, these requirements must be recognized.

4.2.1 Rail

Rail is usually referred to in terms of weight per unit of length (e.g. 132 lbs per yard or 65 kilograms per meter), but there can be different profiles for the same weight of rail. Weight, profile and properties of the steel govern vertical and lateral bending strength, resistance to over-turning and resistance to wear.

For passenger train speeds of 125 mph, a high quality of track surface and alignment will be necessary for a comfortable ride, notwithstanding careful attention by the designer to those vehicle characteristics which affect ride quality. Assuming good quality ballast and ties, track for such a service constructed with 115 or 132 lb/yard rail could be maintained to the necessary line and surface standards much more easily than if it were constructed with lighter rail, particularly if it were also to be subjected to heavy freight train traffic.

The weight of rail selected for use in a given section of track will depend on a number of factors, including traffic density (number of gross tons moved across the section each year), maximum axle load, operating speeds, the degree of curvature, and the purpose of the track. In general terms, high density main lines, carrying cars with high axle loadings at moderate to high speeds along alignments with substantial curvature -- the CN and CP main lines through the Rockies, for example -- will require the highest quality 132 lb or 136 lb CWR; on curves, where lateral forces (and wear) are greatest, specially-formulated alloy rails may be used. On the other hand, a prairie branch line, with annual traffic measured in the thousands of gross tons, a 10 mph speed limit, and little or no curvature, may not justify anything better than used 85 lb jointed rail. Branch lines, sidings, yard tracks, and industrial lines are generally equipped with re-lay rail -- rail which has been taken out of mainline service, often during conversion to continuous welded rail, but which still has useful service life remaining. This rail, which typically may be of 132 lb, 115 lb or 110 lb weight, is cascaded into these less demanding applications. Some CWR rail strings are also now being re-laid; these usually are placed in the most heavily used secondary lines, or in mainline sidings.

Until comparatively recently all of the rail in conventional North American track consisted of 39 ft lengths connected together by means of joint bars and bolts. These require constant and costly maintenance. Irregularities at joints result in higher dynamic wheel loadings, damaging the running surface of the end portions of the rail, the ties, the ballast and even the subgrade. In some circumstances the end of the rail may be bent downward and crushed rock ballast may be pulverized. Joint bars and bolts may be bent or broken, and cracks originating from the bolt hole develop in the rail web. Because of the reduction in maintenance costs and the improved vehicle ride quality that results, most new rail is now welded into continuous strings, approximately one-quarter mile long before laying. The installation of continuous welded rail is facilitated by modern automated equipment, such as the Canron Rail Changeout Machine (RCO) now in use on CN (Figure 4.1).

Standard high carbon rail is normally used in tangent (straight) track in Canada and other parts of the world. The use of alloy and/or heat treated rail in curves to improve wear resistance is becoming widespread.

4.2.2 Ties

Although rolled-steel and composite steel and concrete ties are widely used in other countries, and reinforced concrete is being introduced, most Canadian track ties or sleepers are pressure (creosote) treated timber. Most railways throughout the world consider concrete essential for speeds of 125 mph (200 km/h). One of the reasons for this is the comparatively poor quality timber available in most countries. In the Soviet Union, for example, where more than 20,000 miles of track are laid with concrete ties, the average life of a timber tie is 12 to 15 years (substantially less than Canadian experience).

Ties must withstand environmental attack -- humidity, termites, rot, acidity, frost action, etc. -- and they must also resist fracture (breaking and splitting) bending action and abrasion by the crushed rock ballast, so that they can serve their functions -- maintenance of rail gauge and distribution of load over the ballast section. For timber ties, the wood itself is very important and here geographic considerations are very important. Oak and maple used in Southern Ontario are tough and hard, and hold spikes without splitting, but the West is largely devoid of quality wood. Jackpine serves reasonably well, but is not favoured for mainline trackage, and ties are imported from the United States and as far abroad as the Phillipines.

The heavier axle loads of North America have been a constraint to the use of concrete ties here. Only very recently have designs been developed which will apparently perform satisfactorily in our environment of heavy axle loads and wide temperature variations.

Concrete ties provide a track which requires less maintenance than track laid with timber ties. Its rate of deterioration for any train speed is slower, with the consequent opportunity for improved vehicle ride quality at lower maintenance cost. This is especially so when combined with CWR (continuous welded rail), as is most usually done. Because of their larger surface area and greater stiffness, concrete ties decrease track deflection under load, and, in the experience of British Rail, improve fuel economy.[16]

Following more than ten years of service testing of concrete ties, CN Rail in 1972 made an extensive pilot installation (6.1 track km, 10,000 ties) in a portion of their track near Jasper, Alberta, a territory which suffers rapid rail and track deterioration because of high traffic volume and large numbers of 100-ton cars. In the following two years, 4,500 concrete ties were installed in the re-alignment of their double main track at Kingston, Ontario, and approximately 120,000 in the construction of 73 km of new second track between Winnipeg and Portage La Prairie in Manitoba.

By 1975, observations of the Jasper installation established that the concrete ties were much superior to softwood ties for areas of high curvature where high tonnage is carried in unit trains of high axle load. Economic analysis also favoured the use of concrete.

Canadian National is now in the penultimate year of a tie-laying program that will see 1.5 million concrete ties in track by the end of 1981, many placed there by the Canron P811 Track Renewal Train (Figure 4.2). CN plans to continue with the installation of concrete ties, especially in the area between Vancouver and Capreol, where softwood ties now predominate. Other criteria used to define appropriate sites for concrete tie installations are:

- curves of less than 2,840 ft radius, with not more than one mile of tangent between curves
- heavy tonnage main lines with annual traffic exceeding 20 million gross tons
- a large proportion of traffic carried in 100 ton wagons
- a large proportion of traffic carried in unit trains

Canadian Pacific has not, as yet, indicated a similar interest in concrete ties, although a CP specification for concrete ties does exist.

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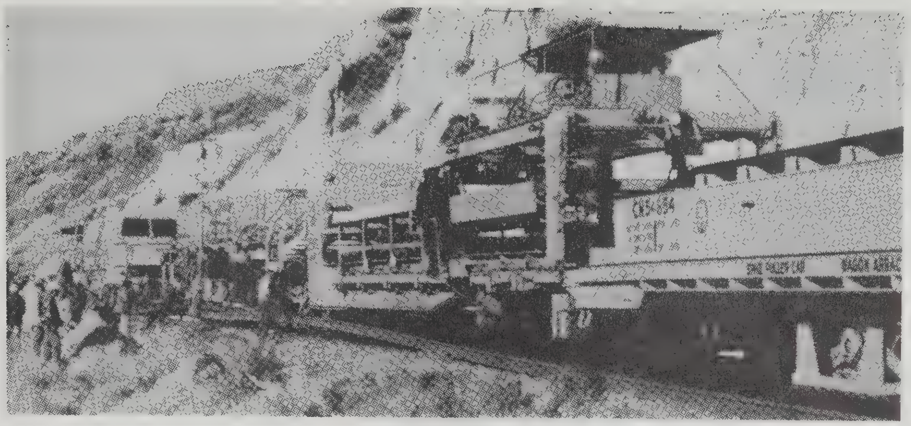
16 No quantified estimate was available



(Railway Gazette International)

Figure 4.1 Canron rail changeout (RCO) machine designed and built for CN. It not only transposes or relays the two strings of rail simultaneously; it also plugs the spike holes and adzes the ties. It is likely to revolutionize the process of rail changing in North America

(Railway Age)

Figure 4.2 Canron P811 track renewal train. This unit picks up wood ties, installs concrete ties and lays new or existing CWR, all in the same operation

4.2.3 Rail Fastenings

The effectiveness of a fastening system for either type of tie is dependent upon its ability to transmit all forces from the rail into the tie, while at the same time preventing rail movement (lateral, longitudinal or rollover). The standard Canadian method of connecting the rail to the tie is by means of spikes. Steel tie plates, placed between the rail base and the tie, reduce the unit pressure on the timber. The rail is held in place laterally, and to a limited extent vertically, by spikes driven (through holes in the tie plates) immediately adjacent to the edge of the rail base so that the spike head hooks over its edge. Rail anchors of various types are used to prevent longitudinal movement of the rail due to traction and braking forces and temperature changes. Usually, the rail anchor fits on the base of the rail, hanging downward, and is driven tightly against the tie face. In Europe, a screw or lock type spike is commonly used with wood ties, frequently in combination with one of the many types of elastic or spring clips.

With concrete ties, a more rugged fastening system is possible. The ability to set fixtures into the tie during its manufacture facilitates rail fastening systems which provide a much greater and more durable hold-down power than is possible with any type of spike in a wood tie. This eliminates the need for separate rail anchors. It also greatly reduces the possibility of rail roll-over.

4.2.4 Ballast

Mainline ballast is normally crushed rock, but sometimes crushed gravel is used, particularly on low density lines.

A combination of qualities is required for the ballast to perform its function with a minimum of maintenance. It must be tough, hard, resistant to frost and chemical action, heavy, angular, and well graded. Ontario and Quebec have sources of superior quality crushed rock ballast, entirely satisfactory for tracks on which high-speed passenger trains and/or a high density of heavy freight traffic operate. Sulphide slags from Sudbury and Noranda, although not strictly rocks, are among these materials.

The West is not as fortunate. Ballast available in the Prairies is of low quality and much of the British Columbia material is only fair. Generally, mainline ballast quality across the system has been improved in recent years, largely due to longer hauls.

Ballast depth and the width of the ballast shoulders (outside the ties) are also important, with a depth of sixteen inches beneath the tie recommended for high-

speed passenger service. Current ballast thickness on Canadian main lines are often substantially below the twelve inches recommended for track carrying a high density of heavy axle loadings, and both railways have extensive programs of ballast upgrading. The function of the ballast is appreciably assisted by a layer of sand or gravel subballast between it and the subgrade. The subballast serves to further distribute the loading from the ballast over the subgrade, prevent mutual penetration of subgrade and ballast, and reduce penetration of frost and rain water into the subgrade.

4.3 Track Maintenance

Safety, reliability and speed, achieved for the lowest possible cost, are primary objectives in train operations. An appropriate track quality level, achieved through the use of suitable track components and the input of regular maintenance, is one factor in achieving those objectves. The dynamic characteristics of the equipment will significantly influence the track quality level and hence the maintenance input required for safety and comfort at given speeds, or alternatively, the maximum permissible safe speed on the track.

The selection of track materials, the geometric tolerances permissible, and thus in turn the maintenance necessary, is dependent on the speed, type and frequency of the trains operated, both freight and passenger. Basic existing line characteristics such as subgrade drainage and climate also affect the track maintenance needed.

Component failures constitute the most common threat to the safety of operations. Such failures include broken or badly worn rails, tie plates, joint bars, bolts, ties and/or switch points. Protection against these occurrences and observation of the condition of drainage structures, bridges and the subgrade itself are the basis for regular track patrol by vehicle and on foot.

Incipient failures of rail in track are identified through monitoring with rail-mounted induction and ultrasonic flaw detection equipment. Similar (but stationary) equipment is used for the inspection of partly worn rail before it is re-installed. All rail welds are examined by magnetic particle test.

Track geometry (surface alignment, cross level and gauge) is monitored with specially instrumented rail-mounted vehicles having the ability to measure track quality at speeds up to 100 mph with an accuracy, objectivity and consistency impossible with manual inspection.

On Canadian railways, the formerly labour-intensive tasks of track maintenance, construction and rehabilitation, are now accomplished by a much reduced work force equipped with machinery specifically designed and constructed for the

work. One result of this conversion has been general replacement of local section[17] forces with mechanized gangs which cover a much extended territory. As an indication of the extent to which mechanized track maintenance and construction have replaced manual methods, it is estimated that the value of the inventory owned by Canadian railways for that purpose is in the order of $250 million.

The process of developing new and improved machinery is a continuing one. Perhaps the most significant recent development has been the rail renewal train. This equipment, in use on CN Rail since 1978, replaces a variety of cranes and other machinery formerly used in the process of rail renewal. It can renew up to 15,000 track feet in a 10 hour work block.

Adequate maintenance includes the laying of several hundred miles of new rail annually by both CP and CN. In general, new rail is used only in principal main tracks to replace rail worn to the extent that it is no longer suitable for heavy service. The partly worn rail removed is relaid on secondary lines, with the rail displaced from the secondary lines being used for yard and siding tracks. Special new rail programs are sometimes undertaken specifically to generate suitable used rail to fill a particular need, such as construction of a new branch line. Rail is expensive, and this "cascading" process aims to ensure that:

- the quality of rail on any part of the system is appropriate for the service conditions to which is is subjected
- the maximum possible life cycle is obtained from all rail in the most economical manner.

4.4 Future Technology

The benefits from an improved track structure are threefold:

- reduced track maintenance
- reduced vehicle maintenance (locomotives and cars)
- increased reliability of train operations.

The increasing use of welded and alloy rail and concrete ties with their inherently superior rail fastenings have already contributed substantially in each of those areas. As more and more of the Canadian system is improved through such component changeout, system reliability will be further increased,

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17 a relatively few men permanently stationed to maintain ten or so miles of track

and maintenance costs and railway operating costs generally should decrease in real (net of inflation) terms.

Reference has already been made to the highly sophisticated machinery now available for replacing rail and installing concrete ties. Similar advances are being made in laser controlled equipment for lining and surfacing. Benefits will consist not only of lower track maintenance costs, but also a stronger, smoother track structure. This improved track will reduce dynamic train action, and hence the loadings imposed by the trains, permitting extension of the maintenance cycle (cost reduction) with no loss in safety or reliability.

5. SIGNALLING AND CONTROL

5.1 Present Practice and Technology

Signalling and control practices, as applied to train operations, have the prime objective of ensuring the safe movement of each train on the line. The safe interaction of trains demands a level of signalling sophistication proportional to the frequency and speed of the trains. Thus, the current spectrum of train control technology is quite broad, ranging from completely unsignalled for branch line freight operations, to computer-aided dispatching and automatic train control on Japan's high-speed passenger lines.

The main control element in most modern railway signal systems is the signal "block" -- a length of track to which entrance is governed by wayside or in-cab signal indicators. In an automatic block signalling system (ABS), these block signals are activated automatically by the presence of a train or the position of interlocked mainline switches. An ABS system can accommodate relatively high train frequencies and speeds on a double track line with uniform train speeds by using multiple aspect signals and minimum permissible block lengths.[18] Continuous in-cab signalling by means of coded track circuits conveys the existing occupancy condition to an in-cab indicator, thus reducing the chance of driver error and permitting a faster recovery from abnormal stoppages. An extension of in-cab signalling is automatic train control (ATC) whereby the locomotive automatically responds to reduced speed requirements or is automatically stopped if the engineman does not respond. Also available are more advanced forms of ATC

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18 The minimum permissible block length is the braking distance of the heaviest train expected on the line. By using multiple aspect signalling, trains may close in on a preceding train but at a reduced speed. For example, on the new 300 km/h Paris-Lyons line in France, block lengths are only 2.1 km in length but a train cannot enter the block adjacent to an occupied block, it must brake to a stop in the preceding block, and slow to speeds of 160 km/h, 220 km/h, and 260 km/h in the third, fourth and fifth removed blocks respectively.

which incorporate wayside minicomputers and on-board microprocessors with continuous two-way data communication. The on-board control unit computes the train's braking distance and maintains a safe distance from the preceding train. This "moving block" system provides reduced headways and adaptability for trains with less than maximum braking distances. Fixed block ATC is widely used in high-speed, high-density passenger service in Europe and Japan, while moving block systems are used on some high-density transit applications.

While ABS and ATC provide an effective means of collision protection, they do not in themselves provide a means of authorizing train movements -- timetable schedules and train orders must be used. This is a severe limitation for a single track railway or a double track railway with trains of mixed speeds, but it may be overcome by adding centralized traffic control (CTC). With CTC, a dispatcher at a central control console can actuate all power-equipped turnout and crossover switches for a track segment, and can usually communicate with the enginemen by VHF radio. He can thus control the routing of trains in meet and overtake situations. It is also possible for him to monitor any track-mounted interrogation devices such as detectors for hot bearings, dragging equipment, flat wheels, shifted load and broken wheels. On more congested lines, computer-aided dispatching can be incorporated. Such a system relieves the dispatcher of some of his repetitive bookkeeping tasks and aids in predicting and resolving train conflicts.

In Canada, the majority of the non-mainline trackage is unsignalled. CP Rail's single track main lines are mostly CTC while its double track main lines are ABS. Some single track enrichments to the main line network are also ABS. CN's main lines, both single and double track, are mostly CTC. Both railways also use CTC in high congestion areas around major yards and cities. The high-capacity signalling system installed on CN's multiple track Lakeshore lines through Toronto is an excellent example of this. These lines must carry mixed freight, passenger and commuter trains with on-line commuter station stops. The different speeds and acceleration and deceleration rates of these various types of trains combined with a high total train density presented an extremely difficult train control situation.

5.2 Future Technology

In the near term, one can expect to see increased use of computers in the dispatching process in Canadian applications. Canada's main lines are predominantly single track and congestion and throughput problems are being experienced as traffic increases. At some locations increased line capacity has been (or is being) achieved through reduction in train conflicts by the addition and/or lengthening of passing tracks. Computer assisted train dispatching can be seen

as a means of reducing the need for additional infrastructure investments, at least for the short term.

A relative decrease in the cost of signalling installations can also be expected. The use of fibre optics rather than signal cable will reduce the cost of CTC installations, and the use of in-cab rather than wayside signal indications can result in further cost savings. Solid state track circuits or the use of tie-mounted axle detectors will also contribute to cost reductions for new installations.

In the long term, one can see the potential for further automation of train handling. The use of on-board microprocessors to monitor important variables such as brake line pressure, speed restriction adherence, and wheel slip are currently available and can provide valuable assistance to the locomotive engineer in achieving effective train handling. However, the present-day system for brake and throttle control is such that large and damaging forces can be generated within many of today's long, heavy freight trains, often notwithstanding the presence of an experienced locomotive engineer at the controls. Improvement will necessitate the development of train-line data transmission capabilities (currently being tested) and the fitting of appropriate sensors and electropneumatic brake controls to each car, as well as further adaptation of microprocessor technology. This type of individual control offers prospects for greatly reduced dynamic train forces with corresponding reductions in lading damage, track wear and locomotive and freight car maintenance costs. Much longer trains would be operated, a distinct advantage in terms of labour cost and track capacity.

Although for normal intercity freight services an ability to operate longer trains would not necessarily be beneficial, it would in unit train service, particularly in territories where such trains constitute all, or the bulk of, the daily traffic. One example of such a service would be the movement of thermal coal to the Lakehead. Another would be the movement of mineral aggregates from Southwestern Ontario to the Metro Toronto area. Savings as a result of a reduction in crew costs would be augmented by reduced inventory costs, the result of being able to achieve a somewhat higher track speed with consequent shorter trip time. In some circumstances, crewless train operation could be utilized to further reduce operating costs. Such an operation has been in existence since 1962 on the Carol Mine Automatic Railway operated by the Iron Ore Company of Canada, Labrador City, Newfoundland. In that service, twenty-car trains move 2,000 net tons from the loading pockets to the dump point, a distance of some seven miles.

Another change, which will improve the reliability of car identification procedures and speed up yard handling, will be the development of fully automated car

identification based on specially-designed closed-circuit television equipment. This will permit remote wayside identification as well as the yard and terminal identification now used.

Similar types of unmanned sensors, again linked through computers to the train control system, will provide improved detection of overheated bearings and dragging equipment, both serious safety hazards. Advanced microelectronic technology should simplify the present problem of identifying the type of wheel bearing (and thus its correct operating temperature). A single installation could identify the car, its location in the consist, check bearing temperatures and equipment configuration, and communicate any problems directly to the train controller -- either on-board or at a central facility.

A further application of microprocessor technology to railway operations, the implementation of which has already begun, involves the use of on-board monitors to collect and analyze performance data and provide rapid diagnostic checks during maintenance cycles. This feature can improve in-service reliability and reduce total maintenance costs, as well as improving the actual over-the-road performance.

6. MODAL COMPARISONS: ENERGY AND COSTS

The development of modal comparisons, whether related to energy use or costs, is complicated by the influence of a wide range of modal characteristics, including physical (equipment weight and aerodynamic profile, engine characteristics, roadway parameters, etc.), operational (speed, traffic mix and density) and economic (transportation capacity utilization, labour and material costs, capital costs) characteristics. For example, railway linehaul fuel consumption[19] is a function of:

payload to tare weight	- energy lost through braking is proportional to <u>total</u> weight, including that of the empty car
aerodynamic shape	- because rail provides particularly low friction operation, aerodynamic drag dominates, even at relatively low speed. Drag is dictated by the "roughness" of the train which is affected by the shape of individual cars and locomotives, the size of gaps between cars and the extent to which cars are marshalled to reduce irregularity of the profile along the train

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19 Linehaul freight accounts for roughly 75 per cent of diesel fuel consumption; 15 per cent is attributable to passenger service operations, and 7 per cent is consumed in yard switching.

gradient and acceleration - uphill travel and acceleration do not in themselves consume energy; they represent a conversion to the potential and kinetic forms (height and velocity). Provided the trains can coast downhill and to a stop, the energy is regained. It is braking that consumes energy, and with a low friction mode like rail, most potential and kinetic energy is lost in this manner

curvature - contact between wheel flange and the rail results in resistance to train motion and is greatest on high curvature track where the train's tendency to move in a straight line is resisted by the track

track modulus (stiffness) - the weight of each axle depresses the track, such that each wheel is effectively climbing a hill

speed - aerodynamic resistance is proportional to the square of the speed

per cent empty backhaul - fuel consumption for empty cars is somewhat lower because of the lower weight, but aerodynamic drag is generally unchanged.

While system average fuel productivity is on the order of 300 net ton-miles per gallon, figures below 150 (typical of express piggyback operation) and above 600 (typical of a slow speed unit train of cylindrical tank cars on stiff level double track) are possible.

As a consequence of the many variables involved, there is no single figure of merit (say, in ton-miles per gallon or cents per ton-mile) which typifies a mode. As will be seen, average measures of energy use and cost vary dramatically with changes in the characteristics of any particular mode.

An impediment to simplified, general comparison of modes is that the desirable basis for comparison is a trip or movement from an origin to a destination which usually involves use of several modes. However, an understanding of the comparative advantage of various modes is essential to construction of comparisons on an origin-destination movement basis, but the particulars of each movement must be recognized.

Carrier costs are not always similarly defined. For example, railway service costs computed by the railways for subsidy or rate hearing purposes include cost of capital, but this cost is not an accounting entry per se, and usually does not appear in costs quoted for other modes. The costs for the road and air modes shown in succeeding sections contain an approximate allowance for cost of capital to rectify this inconsistency.

Government support of transportation includes direct carrier support (primarily subsidies to rail and marine modes) and indirect support through construction, maintenance and operation of transportation infrastructure (primarily highway,

air and marine modes). The latter, indirect support, to the extent that its costs are not recovered from user charges, has the effect of lowering the costs assumed directly by transportation system users (and shown in carriers' accounts). If this support is uneven among modes, comparisons based only on costs assumed by users may be biased. Unfortunately, it is not clear how government infrastructure expenditures -- particularly highway expenditures -- should be allocated to specific groups of users. No attempt has been made in this study to construct such an allocation. Figure 6.1 shows the absolute level of direct and indirect participation by government (all levels) in the various modes.[20] While the figure suggests unequal participation among modes, government costs must be related to traffic levels for specific types of traffic before it can be established whether bias will occur in comparing modes with regard only to carrier costs.

Comparisons of the energy productivity of current intercity modes are generally expressed in net ton-miles or passenger-miles per Imperial gallon, recognizing the almost universal use of petroleum in North American transportation. Where alternative energy sources are contemplated (say, electrification of railways), these comparisons are no longer relevant. When a particular fuel (petroleum) is in short supply, reduction of total energy use is not the relevant criterion; reduction in the use of petroleum-derived energy is.

In addition to direct energy use (mostly petroleum fuels) energy is used in the construction, maintenance and operation of railway facilities and equipment. While this indirect energy use may be simplified in some cases, methods of measurement are not well developed and results are easily misunderstood. Perverse examples excepted, indirect energy in transportation is an order of magnitude lower than direct consumption.

The following subsections present approximate energy use and cost ranges (per ton-mile or passenger-mile) for the various modes. These ranges are very broad; in many cases there is no dominant mode in terms of energy efficiency or cost. These comparisons do not, of course, represent the significant differences among modes in other service attributes (convenience, comfort, frequency, etc.).

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20 The costs shown in Figure 6.1 include depreciation and interest on past investments, rather than annual expenditure on new projects. This approach reduces year-to-year variations due to the lumpiness of large projects.

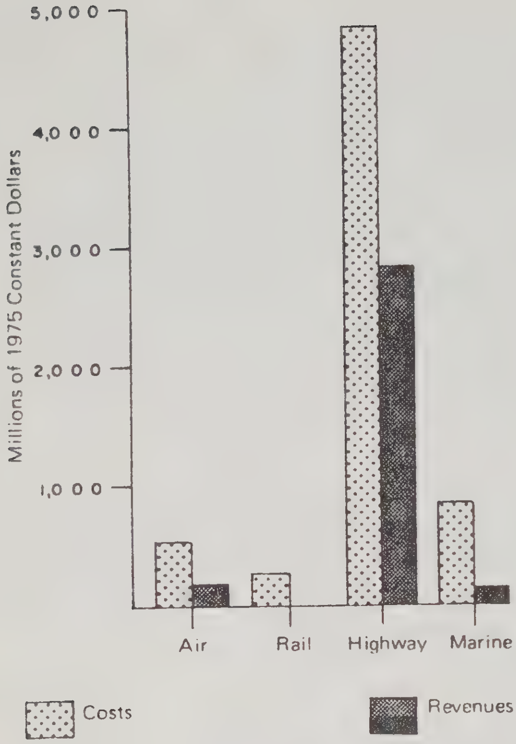

Figure 6.1

Government transport costs and revenues by mode, 1975 (Transport Review, Canadian Transport Commission, March 1979)

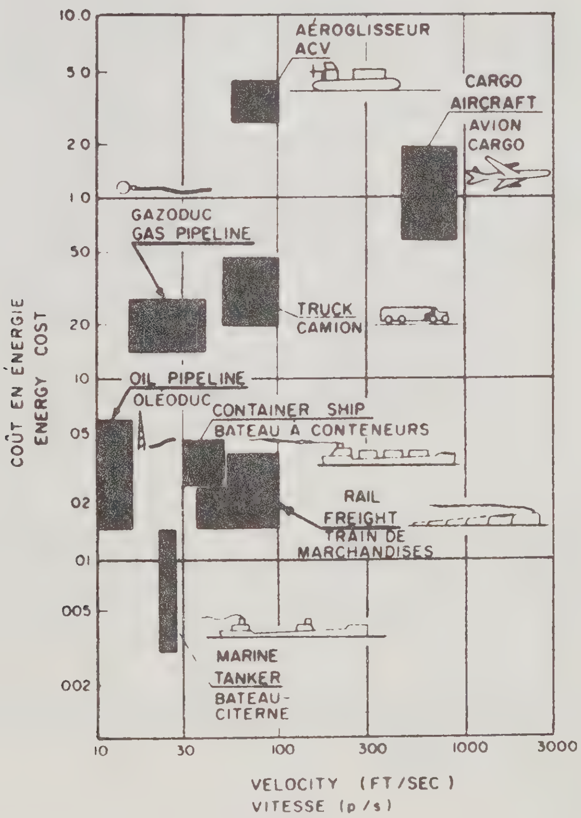

Figure 6.2

Freight transportation energy intensity (Science Dimension, Vol. 6, No. 1, 1974, p. 49)

6.1 Intercity Freight Transportation

6.1.1 Energy Use

The energy intensities of the various freight modes, as developed by the National Research Council, typified by Figure 6.2.[21] While the diagram shows truck as more intensive in its use of energy than rail, there are circumstances (very low traffic density, branchline operations, package freight) where truck operation is the most energy-efficient mode. Other freight modes are shown. Low pressure, large diameter pipelines will generally produce higher energy efficiency than small high pressure pipelines. Cargo aircraft are large fuel users because of the fuel consumed in take-off/landing and the much greater aerodynamic drag encountered at typical speeds.[22]

As noted above, railway linehaul fuel consumption is highly variable, with productivity ranging from below 150 net ton miles per gallon to above 600 net ton miles per gallon (the Canadian railway system average is somewhat above 300). Motor truck fuel consumption can vary from 30 net ton miles per gallon (part loads, high percentage empty miles) to over 125 net ton miles per gallon (heavy loading commodities, low percentage empty miles).

6.1.2 Costs

Figure 6.3 charts approximate estimates of total carrier costs (labour, materials, purchased services and capital costs) for rail, truck and air cargo operations. Lowest rail costs are typical of operations at slow speeds hauling heavy, bulk commodities over long distances, while higher costs apply to low density cargoes, express (or piggyback) trains, and to cargoes requiring special handling (e.g. explosives). The truck cost represents an amalgam of lengths of haul, truck size, commodity type, and loadings. Lower air cargo costs are typical of large commericial jet aircraft (B747) on longer hauls, while higher costs reflect smaller jet aircraft (B727) on somewhat shorter hauls. Small turboprop aircraft can considerably exceed these unit costs. Also as fuel costs rise, air cargo costs will rise relatively faster than costs for other modes. The costs shown in Figure 6.3 are for all-cargo air service. Cargo carried in the bellies

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21 The energy intensity measure used by NRC is the ratio of the energy content of fuel used in transportation (in foot-pounds <u>force</u>) to the useful product (in foot-pounds <u>mass</u>, representing mass transported over a given distance). The right-hand <u>scale</u> shows the more conventional net-ton-miles per gallon equivalent (computed by multiplying the inverse of the intensity measure by 10.5).

22 Where cargo is carried in otherwise unusable space, as in the belly of a passenger aircraft, incremental energy use on the air leg may be very low.

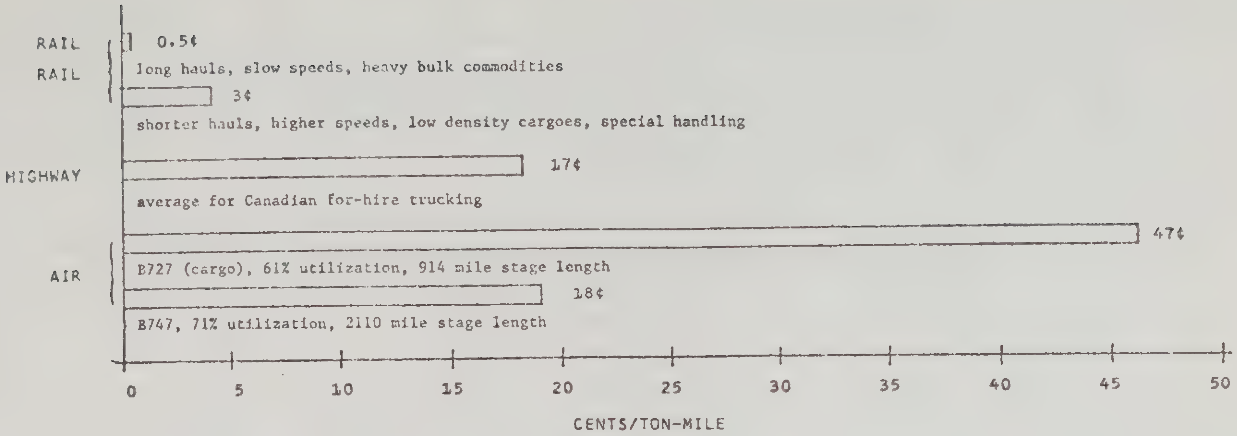

Figure 6.3 Freight carrier unit costs - rail, highway and air carriers ($1978, excludes net government infrastructure costs)

of passenger aircraft do not incur substantial flying costs, but incur indirect costs (terminal handling, etc.). The costs of such cargo may be as low as one-third of the costs shown in Figure 6.3.

6.2 Intercity Passenger Transportation

6.2.1 Energy Use

Typical energy productivity for the rail, bus, air and automobile modes are charted in Figure 6.4. A given mode will have a particular set of markets for which its attributes are especially well suited. Thus, wide-bodied aircraft are particularly well suited to uninterrupted long-distance flights on routes with a substantial demand for service, while a highway coach is excellent for short-haul services with frequent stops and a relatively low demand for service. Modern high-speed rail services can provide a first-rate combination of comfort and speed for trips of 200 to 1,000 kilometers with a limited number of stops, on routes which display high to medium levels of travel demand.

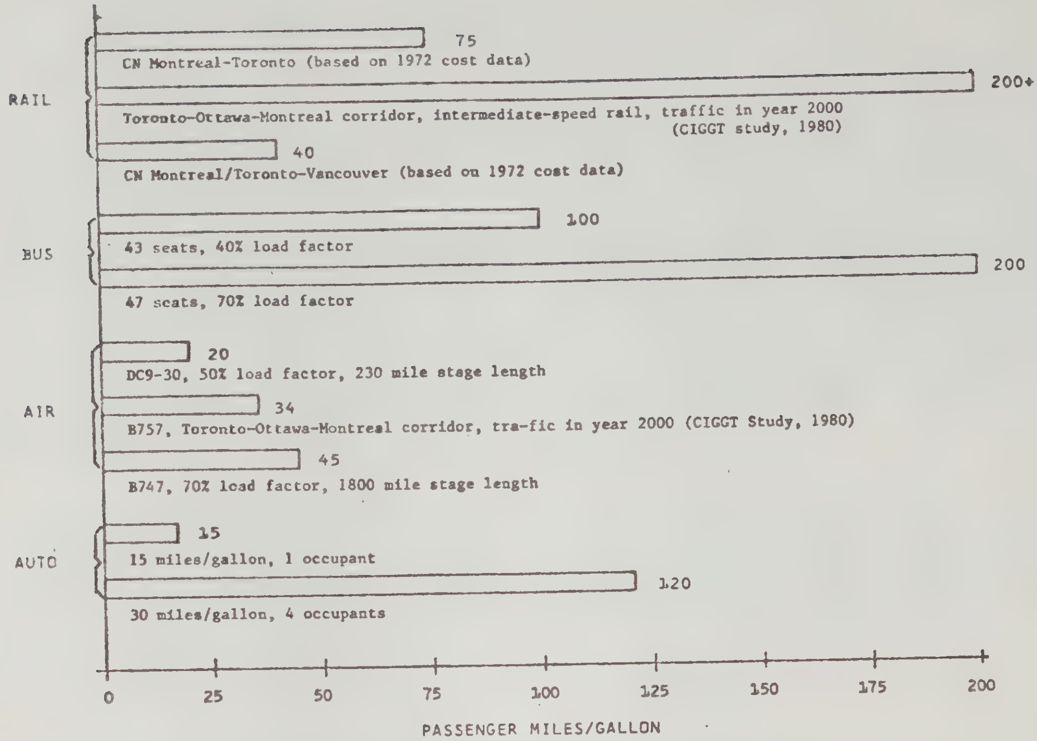

Figure 6.4 Passenger system energy use

A number of factors complicate direct comparisons between modes on anything but a route-and-service-specific basis, especially for passenger operations. Two of these elements, which are interrelated to a considerable degree, are modal attractiveness and load factor. Load factor -- the number of occupied seats divided by the number of available seats -- is quite straightforward, but modal attractiveness is a composite of perceived attributes -- comfort, speed, accessibility, cost, prestige, and so on -- that will vary from individual to individual.[23] This factor has a considerable input to modal energy intensity, especially the ability of a mode to capture patronage from other services. A high-speed rail service with all-first-class service would be more energy intensive than a slower, less comfortable, less prestigious service, but if the former can attract ridership from aircraft and automobiles where the latter cannot, the overall energy intensity of the high-speed system may be superior.

6.2.2 Costs

Typical unit costs (including labour, material, purchased services and capital costs) for the rail, air and auto modes are shown in Figure 6.5. CIGGT data on air and rail performance are taken from a recent study on gound systems in the Toronto-Ottawa-Montreal corridor.[24] Replacement of existing corridor services

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23 This also affects modal selection for freight. Some shippers base their transportation decisions on historical perceptions which are no longer valid. The current increase in transportation costs has served to reduce this phenomenon, however.

24 "Alternatives to Air: A Feasible Concept for the Toronto-Ottawa-Montreal Corridor," CIGGT Report No. 80-4, July 1980 (in preparation)

with one of these candidate high-speed ground systems would lower costs (per passenger-mile) through improved efficiency and increased traffic. While improvements in transcontinental service costs may be possible, unit costs are likely to be higher than for corridor service because of the greater requirement for passenger service facilities (e.g. dining and sleeping cars). CIGGT's analysis includes use of a higher-capacity, more-fuel-efficient aircraft on the corridor, represented by the Boeing 757, but use of a "world" price for oil in the study, coupled with high aircraft replacement costs, results in higher unit costs than is shown by estimates based on historical account data (represented by DC9 costs based on data from the U.S. Civil Aeronatics Board).

All costs (including capital costs) are included in automobile estimates. As such, these estimates do not reflect the "perceived" cost (usually measured as the cost of gasoline and oil) on which many drivers base their modal choices.

The air and bus modes carry significant amounts of high-value express cargo as part of their passenger operations, gaining on the order of 10 to 20 per cent of their total revenue from such sources. These revenues reduce the price that must on average be charged passengers to somewhat below the unit costs shown in Figure 6.5. Current rail passenger services gain minimal revenues from express cargo, but new high-speed, high-frequency corridor services would attract such traffic.

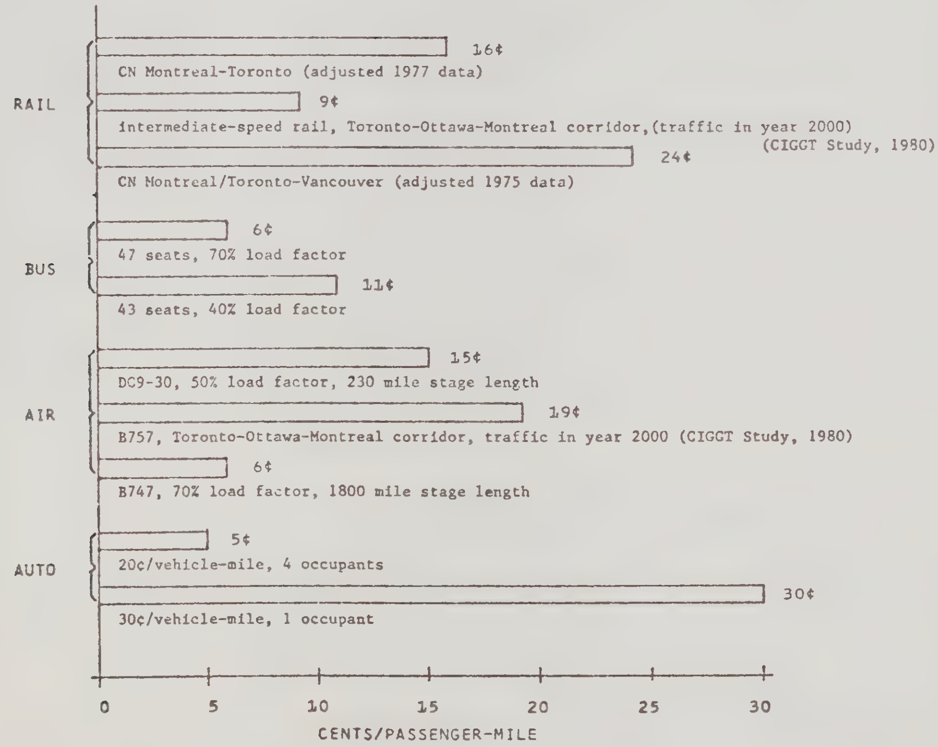

Figure 6.5 Passenger system unit costs (expressed in 1978 dollars, excluding net government infrastructure costs)

6.3 Mixed-Mode Freight Operations

The technology required to support intermodal operations (piggyback trailer, containers, side transfer loaders, container cranes, etc.) is well developed. Multi-modal companies have tended to facilitate such movements, where they are justified, but there remain areas where coordination is poor because non-railway-owned trucking companies fear that such coordination might compromise their role as principals in dealings with customers.

A carefully controlled, independent analysis of the relative fuel efficiency of two competing modes in actual operation, recently completed by the U.S. Department of Energy, found that the trailer-on-flat-car (TOFC) "Sprint" trains, operating between Chicago and Milwaukee, averaged 172.9 revenue ton-miles per gallon, versus 86.9 for trucks operating between the same cities during the same time period. This 2:1 ratio reflects the high ratio of tare to gross weight inherent in piggyback operation; in terms of gross tons handled, rail enjoyed a better than a 4:1 advantage. The use of specially-designed low-tare TOFC equipment would further improve the revenue ton-miles per gallon position of rail.

6.3.1 Mixed-Mode Passenger Travel

Although the development of an integrated passenger transportation system offers the greatest hope for substantial fuel economies, cost savings and improved levels of service, modal coordination is distressingly low at the present time. Bus, rail and air terminals are invariably located at some distance from one another, schedules seldom allow for prompt and convenient interconnections in both directions, and operators display an overwhelming lack of enthusiasm whenever such considerations are mentioned. The move towards a common rail/air reservation system is a step in the right direction (and should be treated as such despite early teething troubles), but it is fifteen years late. Bus operations remain a force unto themselves. The net result of this is to force unimodal traffic and deny the traveller any ability to select a combination of modes advantageous to his or her personal convenience, financial position, or desire to assist in national efforts to reduce our per capita usage of petroleum.

7. RAILWAY RESEARCH AND DEVELOPMENT

During the latter half of the nineteenth and early twentieth centuries, the dramatic growth of the railway industry sparked innovative effort on a very large scale -- comparable, in its day, to the R&D explosion fueled by expansion of the aerospace industry in the 1950's and 1960's. Unfortunately, railway-oriented research and development virtually ceased for several decades thereafter, at least in North America. There was a certain degree of technological

adaptation -- the modification of techniques or devices developed for other applications -- but very little innovative research; the industry had matured, and many were prepared to let it fade quietly away. This situation prevailed until relatively recently, and even today research and development remains a rather modest part of the North American railway environment.

The Canadian railways have generally been more active in research than their U.S. counterparts, and have been increasing their effort since the mid-1960's. However, the effort has remained rather limited, as can be quickly illustrated. In 1977, Canada's Gross National Product was about 210.1 billion dollars; more than 20 per cent of this, or at least 42 billion dollars, was provided by transportation or transportation-related activities. During the same period, 174 million dollars was spent on all transportation R&D -- about 4/10th of one per cent of the transportation-generated GNP. Of this, only six per cent was spent on rail-related R&D.[25] This amounts to less than 10.5 million dollars, or .00024 of the transportation-related GNP. The indicated desire of the federal government to increase the proportion of GNP spent on R&D from one per cent to 1.5 per cent by 1985 becomes quite meaningless in light of this -- transportation in general, and rail in particular. Table 7.1 summarizes a breakdown of the 1977 budget by mode.

TABLE 7.1

TRANSPORTATION R&D EXPENDITURES AS A PROPORTION OF GNP - 1977
($1977 millions)

(1) 1977 GNP, Total = $210,132.0
(2) 1977 GNP, Transportation-Related = $ 42,202.6
(3) 1977 Transportation R&D, Total = $ 174.0

	Rail	Marine	Road	Air	Other	Total
$ Amount	10.44	13.92	20.88	116.58	12.18	174.0
% of (1) above	0.006	0.007	0.010	0.055	0.006	0.083
% of (2) above	0.024	0.033	0.050	0.277	0.029	0.4130
% of (3) above	6	8	12	67	7	100

Considering expenditures relative to industry revenues, in 1977 CN Rail and CP Rail had gross revenue totalling $3,159.2 million. Total rail R&D funding, including that provided by non-railway sources, was $10.44 million, or 3/10th of one per cent of the gross revenues for 1977.

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25 Presentation to CIGGT Council Meeting, 7 May 1980, E.H. Gilliat, Director, Freight Development Branch, Transport Canada.

Even this is probably an overstatement, since much of the "research and development" work carried out by the railways is short-term "fire fighting" aimed at specific problems. This work is important, but it is also necessary to promote long-term basic research. Such research as is funded is distributed among a number of different segments of the industry, and also includes some university and consulting organizations.

The Japanese have remained in the forefront of rail research and development, especially as regards magnetically-levitated vehicle research and the development of sophisticated automatic train control systems. The JNR Technical Research Centre carries out a broad range of research projects, including many aimed at maintaining the superior performance of the expanding Shinkansen system. JNR also operates its own fully-accredited degree-granting university, to ensure a steady flow of well-educated young engineers and managers. Japan spends between 2.5 and 3.3 per cent of its GNP on all R&D-related activities.

In France, which has long been the European leader in the development and use of high-speed electric and gas-turbine passenger equipment and infrastructure, over 7 per cent of the industry is employed in research and development -- about 1,500 people in 1975. The scope of French research is also quite broad, including fundamental research in metallurgy and electronics as well as more applied development programs. Considerable effort is also devoted to economic analysis and operational research.

Railway research in Britain, which in recent years has been strongly supported by both British Railways and the Department of Transport, is largely carried out under the auspices of the Railway Technical Centre in Derby. This facility is well-staffed with both scientists and engineers, and is able to carry out a full spectrum of laboratory and field tests as well as theoretical investigations. It has played a leading role in the development of the HST and APT high-speed passenger trains. It is interesting to note that this level of effort has been sustained during a period when spending on R&D in the British economy as a whole <u>declined</u> by almost 30 per cent, to the point where Britain was spending about half the proportion of their GNP as Japan and Germany.

The Canadian situation is clearly unsatisfactory, particularly if Canada is to actively pursue export markets for railway technology. At the very least, R&D expenditures on railway-related topics should attain the level for the economy as a whole, be it 1 per cent or 1.5 per cent, or whatever. Since the substitution of railway passenger and freight service for selected portions of the markets now served by automobiles, airlines, and trucks offers substantial potential for petroleum fuel conservation, a superproportional level of R&D expenditure would not be unreasonable. However, this level of funding must be sustained over a relatively long term -- at least ten years, and ideally

longer. Research projects do not all have quick payoffs. There will be failures and dead-ends as well as successes, and many of the successes will require considerable lead times for implementation. Planning horizons that coincide with the latest date for the next election are not conducive to successful, sustained research in any field, and transportation is no exception to this.

7.1 Railway R&D in Canada

Such railway-oriented R&D effort as exists in Canada is spread rather broadly across the railways, governmental agencies, industries, consultants and rail-related manufacturing industries.

Canadian National has the largest technical research and development component of the Canadian railways with a staff of eighty at CN Rail's Research Centre, plus a small research contingent at each regional headquarters. CN also supports operational economic evaluation and cost sudy groups, with a staff of 110 in all. Much of the Research Centre's work load consists of monitoring product and component quality, investigation of failures such as broken wheels, rails, etc., and a search for remedies to improve component service life. As well the research laboratories have made major contributions to improved operations through design and development of complex electronic and mechanical equipment such as a track quality measurement car, locomotive simulators, weigh-in-motion scales, articulated trucks, and locomotive anti-wheel slip devices.

Canadian Pacific's research group consists of a staff of approximately seventy at Headquarters in Montreal, plus small groups on field assignments in the Divisions. CP does some equipment and component testing, similar to CN, as well as engineering and economic evaluation of such things as intermodal and container terminals, terminal operations, and maintenance planning.

The Division of Mechanical Engineering of the National Research Council conducts, on request, a certain amount of railway research at their railway laboratory in Ottawa, as well as the cold temperature laboratories in the same location and in the wear laboratories in Vancouver. They possess a large-scale roller-rig for the study of rail car components, particularly running gear, as well as a railcar impact testing section and various special purpose testing rigs, particularly for such components as traction motors. NRC has done considerable investigative work over the years on the operation of railway switches at low temperatures.

Transport Canada's Transportation Research and Development Centre (TDC) does not itself conduct research, but does fund, organize and manage a substantial number of railway-related research projects each year. Jointly with the Railway

Association of Canada (RAC), TDC supports the TDC/RAC Railway Advisory Committee which identifies and defines research needs within the industry and seeks sponsors for their resolution.

The Research and Development Branch of the Ontario Ministry of Transportation and Communications carries out research in support of rail transit operations, including investigation of vehicle dynamics, guideway design and propulsion systems. This organization is also involved in a resilient wheel design and testing program.

The Urban Transportation Development Corporation and its subsidiary, Metro Canada, conduct research and development at its Millhaven Test Site near Kingston, Ontario. This corporation, wholly owned by the Government of Ontario, also coordinates and manages related research conducted by others, and provides international consulting services.

The Canadian Institute of Guided Ground Transport (CIGGT) is by far the largest of the university-based transportation research and development institutes in Canada, and is unique in North America. CIGGT, a partnership of Transport Canada, Canadian National, Canadian Pacific and Queen's University, operates with a budget derived largely from contract research projects. Clients include the sponsors , other Canadian and foreign railways, provincial governments, foreign governmental agencies, and resource and industrial corporations.

The Toronto/York Joint Program on Transportation devotes a considerable portion of its research effort to railway-oriented problems. Research is conducted by faculty members and graduate students as a part of the academic program of the two universities.

Other university-based transportation research centres that have been involved with rail include the Centre for Transportation Studies at the University of British Columbia, the Centre for Transportation Studies at the University of Manitoba, Centre de Recherche sur des Transports at University of Montreal, and the transportation programs at the University of Waterloo. All are primarily concerned with academic teaching, although the UBC Centre played a substantial consulting role in the recent Royal Commission study of the British Columbia Railway, and the Manitoba group has done some work on grain transportation. Centre de Recherche at Universite de Montreal and the Waterloo program are largely focussed on urban transportation problems.

Other Canadian universities, such as Carleton, occasionally do individual projects related to railways.

The locomotive and railway transport division of Bombardier Ltd develops and manufactures railway locomotives for domestic and export markets. In consortium with Alcan and Hawker-Siddeley, MLW designed and developed the LRC (Light Rapid Comfortable) "tilt body" train which is currently being produced for operational testing in the United States.

Hawker-Siddeley is a leading manufacturer of light alloy freight cars, steel freight cars, railway wheels and trucks, and subway cars for both foreign and domestic markets, and has designed some of the most modern subway and commuter cars available anywhere.

Dominion Foundry and Steel Company's Product Development Department carries out design, research and development work in support of its railway truck manufacturing activities. Considerable R&D work is also done on transport and vehicle systems.

Other Canadian railway industry manufacturers (CGE, PROCOR, General Motors Canada (Electro-Motive), Marine Industries Ltd, National Steel Car) perform a limited research and development function in direct support of manufacturing activities. In addition, Modern Track Machinery Canada Ltd, Plasser Machinery Corporation Ltd, Railcar Manufacturing, and in particular Canron Ltd do development work on track maintenance machinery for Canadian conditions.

7.2 Future Trends and Requirements

An overview of the problems which Canadian railways will be forced to face in future years suggests that two interrelated but distinct streams of research and development effort will be required. One of these thrusts will be largely -- but not exclusively -- technological in orientation and will be carried out by and for the operating railways and equipment manufacturers. Consequently, this stream of effort, which will incorporate most projects with high returns and short payback periods, will be almost exclusively freight oriented. Such tasks as car redesign to reduce tare weight, increase cubic capacity and permit heavier loads, improvements to locomotive fuel efficiency, and continued development and implementation of steerable trucks will be given emphasis.

In the same vein but within a slightly longer time frame will be continued stress on track-train dynamics. This research can contribute to decisions on rail and wheel metallurgy, wheel design, tie and tie fastener design, ballast section design and materials specification, truck design, and the overall design of rolling stock and motive power. Technological changes to improve the productivity of maintenance-of-way forces will also be of great importance.

More broadly applicable will be the need to increase the reliability of rail equipment. Rail systems are increasingly operating at or near capacity, so that a simple component failure can produce adverse effects that reach far beyond the individual unit or train affected. The realization that the cost of these far-reaching consequences is the true cost of the component failure should increase the funding available for research.

The second stream of research activity will be concerned with strategic issues, the most fundamental of which is a definition of the role which the Canadian railways will be expected to play over the next twenty to thirty years. Work on these questions, while involving railway expertise, will be largly carried out by or for governmental or quasi-governmental agencies. Issues like mainline electrification, rationalization of the grain-handling system (including changes to the Crowsnest Pass rates), the implementation of high-speed passenger systems (and the whole question of coordination and competition among the rail, air and bus modes) must be considered at this level.

There is little doubt that work on most of the tactical items noted in connection with the first thrust of research will be pursued with considerable vigour by Canadian (and, to a lesser extent, U.S.) railroads, since all these avenues of research offer opportunities for substantial rates of return in the near term. This should be encouraged by government, either directly, through matching funds, or indirectly, through increased incentives for R&D expenditure. However, consideration, and especially implementation, of solutions to the strategic issues identified with the second axis of research will require a much greater degree of government involvement, as a prime mover as well as source of funds. Without a clear commitment on the part of professional transportation planners within government -- and on the part of their political masters -- to <u>stategic</u> planning, those critically important issues cannot, and will not, be adequately addressed. Politicians -- and, for that matter, the general public -- have been described as having 100-year memories and planning horizons that reach as far as the next election. This orientation is no longer adequate. Tomorrow will be substantially different from today, and while we cannot define with certainty what will occur, the boundary conditions can be set down with some confidence, so that adequate contingency planning can be carried out within these limits. When the "best action" converges for a large number of possible features, both professional and government leaders must be prepared to <u>act</u> to implement the recommended solutions -- long lead times for major infrastructure make "muddling through" an unacceptable option.

INDUSTRIAL OPPORTUNITIES

IN THE

RAILWAY EQUIPMENT INDUSTRY

IN

ONTARIO

INDUSTRY SECTOR POLICY BRANCH
MINISTRY OF INDUSTRY AND TOURISM
JUNE 12, 1980

TABLE OF CONTENTS

INTRODUCTION

The purpose of this paper is to identify the potential industrial benefits to Ontario from railway technology development.

The history of rail motive power illustrates the way in which major technological change can revolutionize an industry. During the first 100 years of North American rail history the motive power was steam. Following the steam power era came the advent of a two-stroke diesel, small enough and powerful enough to be used in a locomotive. Over a period of about 15 years virtually all the steam locomotives disappeared from service. The first generation diesels were of 1,500 to 1,750 horse power (h.p.) capacity but as railroads found it more economical to operate larger, heavier trains it became necessary to use several of these smaller units to handle the load. It was obvious that large cost savings could be realized if multiple small locomotives could be replaced by fewer and larger locomotives. The quantum jump in engine power occurred with the introduction of the exhaust driven turbocharger in 1959. Along with other refinements in railway technology, this invention produced the second generation of diesel locomotive rated at 3,000 to 4,000 h.p. As a result of this further engine innovation, locomotive fleets have actually been reduced in numbers over the last fifteen years while the work done (measured in ton-miles) has increased. We have locomotives today that have reached 5,000 h.p. in experimental units.

The most evident change in freight car technology has been the trend toward purpose-built cars with a decline in the number of boxcars in service. Container and piggyback service are replacing the portion of boxcars previously used to move

merchandise and manufactured goods in an effort to gain some of this market back from the trucking industry. This serves as a good explanation for the increasing number of flatcars in service to carry containers and trailers in recent years.

As far as railway trackage is concerned, the greatest period of railway expansion terminated with the collapse of the stock market in 1929. In addition to the Great Depression which followed this collapse, a drought condition developed across the prairies and the requirement for railway expansion was further reduced. Isolated expansion projects took place with; a line to Port Churchill, to mineral developments including the Quebec North Shore and Labrador line from Seven Islands to Schefferville, and the northward extension of Northern Alberta and Pacific Great Eastern Railways.

The Canadian manufacturers of railroad rolling stock are, indeed, caught in a feast-or-famine dilemma. Their cyclical patterns of industry performance are indicative of the ever changing supply and demand conditions indigenous to their manufacturing sector. This market fluctuation is seen in Table 1 under the TRADE BALANCE column. During three of the eight years shown, Canada had a positive trade balance in its railroad rolling stock industry. Just the opposite was true in the remaining five years. It is not at all uncommon for manufacturers of railway equipment and accessories to be faced with extended periods of slow to sluggish business performance, followed shortly thereafter by a boom time in which production and sales increase dramatically.

The cyclical nature of this industrial sector cannot be over-emphasized. General Motors of Canada, Ltd., Diesel Division, London, Ontario (specializing in locomotive production) enjoyed a substantial increase of 33 locomotives in export sales in 1972, followed by another increase of 42 units in 1973 when the markets of Mexico and Yugoslavia opened up due to railway expansion. Two years of decline in export sales were then experienced with another healthy upsurge coming in 1976 as Egypt and Algeria purchased GM locomotives. A sluggish two years again followed, checked by a dynamic rise in locomotive exportation in 1979 due to the respective markets of New Zealand, Togo, Ivory, Pakistan and the U.S.A. Owing to the competitive size of G.M. Diesel Division and also to the fact that locomotives comprise such a large proportion of total railroad rolling stock, it is not surprising that G.M.'s strong performance years coincide quite closely with the positive trade balance years.

Hawker Siddeley, Thunder Bay, Ontario enjoyed an unprecedented sale of 46 passenger cars to the U.S.A. in 1972. Four years of export market slowdown ensued, only to be met by an expanding passenger car demand in Mexico in 1977-78 and in Boston in 1978-79.

Procor Limited, Oakville, Ontario, a firm specializing in the the building and leasing of tanker cars, leased an additional 850 cars in the two years following 1972, with leasing decreases of 150 cars, 600 cars and 100 cars occurring in 1975, 1976 and 1977 respectively. Many of these leased cars went to western Canada as the oil and petrochemical industries came on stream.

-4-

Tanker shipments of propane, butane and sulphuric acid for C.I.L. out of Copper Cliff in Ontario also spurred the demand for these cars.

The cyclical characteristic of this industry being established, the report analyzes the performance of individual suppliers of railway rolling stock, assessing the quality of their products, their ability to compete in export trade and their capability of adjusting to various technological developments that may occur.

TABLE 1

S.I.C. 3260 - RAILROAD ROLLING STOCK INDUSTRY
(All Values in Millions of Current Dollars)

YEAR	EXPORTS	IMPORTS	TRADE BALANCE	TRADE TURNOVER	SHIPMENTS	CANADIAN MARKET	TOTAL DEMAND
1970	19.0	32.0	-13.0	52.0	223.0	235.0	255.0
1971	33.0	44.0	-11.0	77.0	252.0	263.0	296.0
1972	74.0	63.0	11.0	137.0	304.0	293.0	367.0
1973	73.0	50.0	23.0	123.0	341.0	317.0	391.0
1974	40.0	82.0	-42.0	122.0	443.0	485.0	525.0
1975	71.0	107.0	-36.0	178.0	559.0	595.0	666.0
1976	116.0	83.0	33.0	200.0	523.0	491.0	607.0
1977	50.0	97.0	-47.0	147.0	331.0	378.0	428.0
1978	115.0	145.0	-30.0	260.0	468.0	498.0	613.0

Exports = Domestic Exports, Less Re-Exports

Imports = Adjusted Imports, Less Re-Exports

Trade Balance = Exports - Imports

Trade Turnover = Exports + Imports

Shipments = Domestic Production

Canadian Market = (Shipments - Exports) + Imports

Total Demand = (Shipments + Imports) OR (Canadian Market + Exports)

Source: Statistics Canada, CENSUS OF MANUFACTURERS and Catalogue No. 31-525.

TABLE 2

S.I.C. 3260 - RAILROAD ROLLING STOCK INDUSTRY
(Thousands of Current Dollars)

(1) MANUFACTURING STATISTICS	CANADA 1976	ONTARIO 1976	CANADA 1977	ONTARIO 1977	CANADA 1978	ONTARIO 1978
Number of Establishments	17	9	16	8	16	8
Number of Production Workers	6,164	3,135	4,345	2,551	5,813	2,925
Number of Total Employees	8,626	4,424	6,557	3,854	8,327	4,335
Cost of Materials and Supplies	274,689	150,889	240,253	160,031	324,871	186,537
Value of Production ($'000)	496,975	305,022	435,062	259,874	561,586	309,335
Value Added - Manufacturing ($'000)	213,654	151,300	186,478	97,154	226,223	119,410
(2) NUMBER OF ESTABLISHMENTS BY EMPLOYMENT SIZE						
1-4	2	-	2	-	2	-
5-9	-	-	2	2	1	1
10-19	2	2	-	-	1	1
20-49	1	1	1	1	1	1
50-99	-	-	-	-	-	-
100-199	2	1	2	1	2	1
200-499	5	2	4	1	3	1
500-999	1	1	3	1	2	1
1,000+	4	2	2	2	4	2

Source: Statistics Canada, RAILROAD ROLLING STOCK INDUSTRY, Catalogue No. 42-211, Annual.

MAJOR SUPPLIERS OF RAILWAY EQUIPMENT
IN THE
PROVINCE OF ONTARIO

SUPPLIER	EMPLOYMENT (# OF PERSONS)	SALES ($) M=000 MM=000,000	OWNERSHIP	PRODUCTS
1) Algoma Steel Corporation Ltd., Sault Ste. Marie *	13,000**	864,221M	CAN.	Iron, steel, coal, iron ore, rails and accessories, steel blooms, billets, slabs, pipes, tubing, rods.
2) Beclawat Ltd., Belleville *	65**	N/A	U.S.A.	Metal sash, windows, door hardware, safety glass for transportation equipment.
3) Buffalo Brake Beam Company Hamilton *	20	N/A	U.S.A.	Railroad freight cars, brake beams, brake shoe kegs, unit side frame wear plates, disc brakes and freight car container pedestals.
4) Canadian Advance Carmover Co. Ltd., Welland	2	N/A	U.S.A.	Car movers.
5) Canadian General Electric Company Ltd., Toronto *	18,800**	1,070MM	CAN.	Electric apparatus, supplies, lamps and appliances, outdoor fluorescent lamps.
6) Canadian General Electric Company Ltd., Industrial Apparatus Department, Apparatus Service Shop, Burlington	41**	N/A	CAN.	Manufacture and repair of electric motors and generators, air circuit breakers, switch gear, railway, mining and industrial locomotives, hydraulic turbines and turbine generators, babbitt bearings and thrust plates, machine repair, stator, armature and field coil.
7) Canron Railgroup, Railway Division, Toronto *	45	N/A	CAN.	Ballast equalizers, spike drivers and pullers, drills and bolters, tie renewers, rail lubricators.

SUPPLIER	EMPLOYMENT (# OF PERSONS)	SALES ($) M=000 MM=000,000	OWNERSHIP	PRODUCTS
8) * Dominion Brake Shoe Division, Abex Industries Ltd., Niagara Falls	148	N/A	U.S.A.	Railway brake shoes, railroad trackwork and railway specialties.
9) Fairmont Railway Motors Ltd., Malton	N/A	N/A	U.S.A.	Motor driven rail cars and hand cars.
10) * General Motors of Canada Ltd., Diesel Division, London	2,400**	N/A	U.S.A.	Diesel-electric locomotives, off-highway trucks, front-end loaders, armoured vehicles (military).
11) Great Lakes Rail Ltd. Thunder Bay	40	2,780M	CAN.	Railway components.
12) * Hawker-Siddeley Canada Ltd., Thunder Bay, Canadian Car Division	1,100	N/A	U.K.	Passenger rail cars--subway, commuter, and main line.
13) Hawker-Siddeley Canada Ltd., Toronto	6,990** (includes all divisions of Hawker-Siddeley)	398MM	U.K.	Passenger rail cars, sawmill equipment, highway chassis, trailers, electronic structures, railway wheels, castings, axles, forgings and freight cars, aircraft.
14) Lecky Machinery, Ltd., Haileybury	8**	N/A	CAN.	Mining, mineral processing machinery + equipment, diesel locomotives.
15) * National Steel Car Corporation Ltd., Hamilton	1,400	100MM	CAN.	Railway freight cars, industrial rail cars.
16) Northland Rubber & Plastics Ltd., Ajax	27**	N/A	CAN.	Airbrake hose and specialty rubber products.
17) * Hiram L. Piper Company Ltd., Kingston	30**	N/A	CAN.	Metal specialties, marine and railroad supplies.

SUPPLIER	EMPLOYMENT (# OF PERSONS)	SALES ($) M=000 MM=000,000	OWNERSHIP	PRODUCTS
18) Procor Ltd., Oakville	1,400**	87,600M	U.S.A.	Rail freight cars.
19) Bert Pyke Company Ltd., Oshawa	64	N/A	CAN.	Railway maintenance machinery.
20) Railcar Company Ltd., Lancaster	20	N/A	CAN.	Railway inspection motor cars, railway signal equipment.
21) Railcar Company Ltd., Lindsay	12	N/A	CAN.	On and off railway equipment, special machinery + light structural equipment.
22) * Simmonds Precision Canada Ltd., Mississauga	22**	2,000M	U.S.A.	Commercial gauges for indicating and recording.
23) * Steadman Containers Ltd., Brampton	100**	N/A	U.S.A.	Containers and container equipment.
24) Wabco Ltd., Westinghouse Air Brake Division, Stoney Creek	500**	40,000M	U.S.A.	Railway products, air brake systems for locomotives and rail cars, mass transit control equipment, electropneumatic mass transit and passenger car brake systems, composition brake shoes, air cooled disc brakes.
25) * Whiting Equipment Ltd., Welland	86**	5,700M	U.S.A.	Foundry, pulp and paper making, materials handling and railroad equipment.

*Engaged or seriously interested in export trade.
**Rail and other products.

MAJOR SUPPLIERS OF RAILWAY EQUIPMENT
IN THE REST OF CANADA

SUPPLIER	EMPLOYMENT (# OF PERSONS)	SALES ($) M=000 MM=000,000	OWNERSHIP	PRODUCTS
1) Alloy Mfg. Ltd. Ville St. Pierre, Quebec	18**	5,000M	-	Metal fabricators, aluminum cruisers, houseboats and barges.
2) CAE Lubricators Ltd., Montreal, Quebec	4	5,000	CAN.	Railway journal box lubricators.
3) Canadian Cardwell Company Lachine, Quebec	N/A	N/A	U.S.A.	Friction rubber and friction hydraulic draft gears, brake adjusters, hand brakes.
4) Chapman Industries Ltd. Vancouver, B.C.	129**	11,000M	CAN.	Hydraulic boxcar door openers and loading chutes.
5) * Griffin Steel Foundries, Ltd., St. Hyacinthe, Quebec	400	25,000M	U.S.A.	Pressure poured steel wheels and anchor composition brake shoes for railway and transit service.
6) Hyseco Fluid Systems Ltd., Vancouver, B.C.	N/A	N/A	-	Hydraulic cylinders, winches, presses (çar haul equipment).
7) IEC-Holden Ltd., Montreal, Quebec (Subsidiary of Canadian Corporate Management Co. Ltd.)	N/A	N/A	CAN.	Railroad supplies and equipment and highway transport equipment.
8) McDonald Railway Supplies Co., Ltd., Montreal, Quebec	N/A	N/A	U.S.A.	Railway supplies.
9) McGraw-Edison Ltd., National Electric Coil Division, St. Jean, Quebec	1,500** (Includes all divisions of McGraw-Edison)	N/A	CAN.	Lifting magnets

SUPPLIER	EMPLOYMENT (# OF PERSONS)	SALES ($) M=000 MM=000,000	OWNERSHIP	PRODUCTS
10) Prime Manufacturing (Canada) Ltd., Dorval Quebec	N/A	N/A	CAN.	Railroad supplies and equipment.
11) * Sydney Steel Corporation, Sydney, Nova Scotia	2,400*	78,600M	CAN.	Steel ingots (primary processors) billets, railroad rails, booms, slabs, tie plates, bars.
12) * Trenton Works Division, Hawker-Siddeley, Nova Scotia	See listing of Hawker-Siddeley under Ontario suppliers.		U.K.	Railway freight and tank cars, parts, axles, container transfer devices, box-car loaders.
13) * Upright Brothers Ltd., Edmonton, Alberta	N/A	N/A	CAN.	Air conditioning equipment, furnaces.
14) Vapor Canada Ltd., Montreal, Quebec	250**	10,000M	U.S.A.	Industrial heating apparatus for transportation industry, energy conservation hot water tank.
15) Woodings Canada Limité, Montreal, Quebec	N/A	N/A	CAN.	Castings, forgings, railway clips, anchors, spikes.

*Engaged or seriously interested in export trade.
**Rail and other products.

EXISTING HIGH TECHNOLOGY RAIL RELATED INDUSTRIES IN ONTARIO

Rail systems cannot be defined as being high technology in comparison with advanced aerospace, etc. systems. They can, however, be listed and defined as such in areas where they offer an advance on the standard rail state of the art. In Ontario we have a number of companies that meet these advanced rail standards. The leading companies are as follows:

1. General Motors of Canada Ltd.
   Diesel Division, London, Ontario

   Has pioneered a number of developments in the locomotive field.

   - Designed and built the first GM narrow gauge railway locomotive, and the forerunner of the GM Model G export locomotive.

   - Modified its GP40 model to meet special requirements of the government of Ontario transit commuter operation in the Toronto area and now provides all the locomotives for this GO transit system.

   - Co-operated in developing a system to permit unmanned control of a locomotive, later installed in nine electric locomotives that the Division built for the Iron Ore Company of Canada. These units operate by remote control at the mine site with no on-board perconnel.

   This company however, imports their diesel engines into Canada from the United States.

2. Hawker Siddeley Canada Ltd.
   Canadian Car Division, Thunder Bay, Ontario

   One of the world's leading manufacturers of railway passenger equipment Canadian Car Division of Hawker Siddeley Canada Limited has had a long and successful history--since the late 1880s--as an innovative designer and builder of rail and light transportation equipment, its products include subway cars, rapid transit cars, mainline passenger cars, double-decker cars and light rail vehicles.

   Canadian Car's design and development capabilities include conceptual design, car renderings, interior designs and renderings, production of full-scale models, followed by detailed design and production. Once equipment has been manufactured, the company's team of service personnel will carry on the required service conditions of the contracts.

   Development and construction of the long 75 ft. (22,860 mm) lightweight subway car was pioneered by Canadian Car in the early 1960s. Using aluminum extrusions for the side and upper rails, vertical extrusions, roof bows, body sheathing and roof, with end frame and cross members

of low alloy, high tensile, corrosion resistant steel, the company produced a car structure which is just as strong but about only half the weight per unit length of an all-steel car.

When the government of the Province of Ontario initiated its GO Transit rail commuter service, Canadian Car received the order for 85 ft. (25,908 mm) long passenger coaches and self-propelled diesel-engined cars. First customer for Canadian Car's new double-deck commuter car is also GO Transit.

The double-deck commuter car is 85 ft. (25,908 mm) long, 16 ft. (4,876 mm) high, 9 ft. 7 in. (2,920 mm) wide and has an unloaded weight of approximately 96,000 lb. (43,545 kg). Various interior arrangements can comfortably seat up to 164 passengers.

This company has been very successful on the export market and has good potential as an innovator of future high technology systems.

3. National Steel Car Corporation, Limited
Hamilton, Ontario

National Steel Car builds steel or aluminum railway freight cars for standard, broad or narrow gauge tracks, to AAR specifications for interchange service, or to customer specifications. The company will undertake sizable export orders to AAR specifications.

The company's design engineers will design a new unit from scratch to meet a customer's special requirements or will follow through to completion the design supplied. New designs can be tested in the plant with static and dynamic testing using strain gauges, stress coats and photo-elastic techniques.

On-site facilities at National Steel Car include pattern making, tool and die making, plate work, machining, forming and forging, assembly, shot blasting, painting. Modern welding equipment includes mettalic inert gas shielded arc welding units and plasma arc cutting equipment.

4. Procor Limited
Oakville, Ontario

Procor exports expertise--expertise in the translation of a shipper's needs into an appropriate system coupled with the right hardware and support services, Procor designs railway cars for any purpose, particularly specialized purposes such as pressure flow cars and unit trains, and covers virtually every aspect of physical distribution, starting with how the product is loaded into the rail cars, the cost effectiveness of the car in transit and the system of unloading.

Support systems which Procor supplies include the selection of minimum car inventories, computerized control and implementation of inspection, preventive maintenance and repairs and the compilation of records for controlling a fleet.

Procor has developed its expertise in Canada where it is a major private owner of unit trains and a designer and builder of specialized rail cars and shipping systems. In Canada, the company's support systems include maintenance of spare car inventories, and repair shops across the country.

5. Canron Limited
Railgroup Division, Toronto, Ontario

Canron Railgroup designs and produces a complete range of railway track maintenance equipment, including fully automatic ballast tampers equipped with levelling and lining attachments and also crib and shoulder consolidators, tie renewal equipment, spike drivers, ballast equalizers and snow blowers.

The major objective of the Canron Railgroup is to help railways throughout the world maintain their trackage to the highest standards in the most efficient manner possible. The company's design goal for maintenance equipment is to provide high productivity levels while reducing machine maintenance and down time. The goal is achieved through a combination of design ingenuity, quality materials and workmanship and high component reliability.

6. Bert Pyke Limited
Oshawa, Ontario

Bert Pyke Limited began manufacturing specialized machinery for railways in 1954 with a hydraulic operated tie removing and inserting machine. In 1959 the company developed a machine for cleaning snow from switches in the hump yards that were then being built across the country, and this machine is still widely used on Canadian railraods.

A utility crane and a tie handling crane were later added to the company's production, and most recently a 15-ton rail mounted locomotive type crane was built. All the railway machines are diesel powered and hydraulically operated.

7. Canadian General Electric Ltd.
Peterborough, Ontario

This company is a leading manufacturer of traction equipment for use with diesel electric locomotives. These locomotives are mainly exported with some 50 per cent through the Canadian Export Development Corporation, 25 per cent through C.E.D.A. and 25 per cent commercial.

8. The Steel Company of Canada Ltd.
Hamilton, Ontario

The company manufactures a broad range of high quality parts for use in railway systems. These include the following product categories: hot rolled steel and cold finishing steel; bolts; chemicals; fencing; forgings; closed die; grinding media; merchant wire; nail; oil rods and couplings; pipe and tube; plate, pole line hardware; reinforcing; residential; rod and wire; screws (bulk only); hot rolled semi-finished steel (forging quality); sheet; special products (cultivator shanks, grader blades); tin mill products; track materials; wharf materials.

The company also offers clients highly technical assistance and detailed engineering analysis.

9. Cole, Sherman and Associates Ltd.
Willowdale, Ontario

Serving a variety of railway companies and operating authorities for more than 20 years, this independent Canadian company has developed extensive and unique experience in the planning and design of railway facilities.

Typical projects undertaken by Cole, Sherman and Associates Limited include the provision of total engineering services for the planning, design and implementation of diesel repair shops, spot car repair, passenger car repair and freight car repair facilities, passenger train servicing, customer service centres, yard operations, track layout, modern signalling systems, maintenance-of-way facilities, road-to-rail transshipment terminals, commuter rail repair and servicing facilities, ancillary workshops, stores and crew centre.

10. Penvidic Contracting (1971) Ltd.
Burlington, Ontario

Construction of railway trackage has been Penvidic Contracting's primary activity since the company's incorporation in 1947. Its clients are drawn from both government and the private sector.

Penvidic has become the largest and most experienced railroad construction company in Canada, offering a complete service that includes design, procurement of track structure materials and rolling stock and construction. Its modern equipment and experienced personnel can provide efficient performance on any size of railroad building project.

11. Buffalo Brake Beam Co.
Hamilton, Ontario

Buffalo Brake Beam was a leader in the development of the steel truss type brake beam that replaced earlier types made of wood and suspended from the car body. Later the company originated and developed the unit brake beam system

that is the standard today for freight cars in many areas of the world.

At its Hamilton plant, Buffalo Brake Beam produces No. 18 AAR and No. 24 AAR brake beams for rail freight cars and can meet any special metric or gauge size.

Production includes the unit solid truss brake beam, the original hangerless type, and the truslock beam, both with models for iron or composition shoes. Four different kinds of metal are used in the manufacture because there are four separate wear problems to be solved--one piece forged solid steel truss, steel wear plates heat treated and hardened for long usage, malleable brake heads, hardened steel bushing inserted at wear point in the malleable strut.

The above companies have the capability to supply equipment and services to meet international standards. Many are presently selling on the export market. In addition to the above companies, there are ten other major rail suppliers and service companies located in Ontario that have high technology capability.

EXPORT MARKET FOR NEW RAIL TECHNOLOGY

The Canadian railway manufacturing industries play an active role in the international marketplace. Cost and delivery of the product are not the major considerations in penetrating the overseas markets. Financing, training of staff and technical transfer are among the prime ingredients that make a successful export program. For example: locomotives exported from Canada in recent years have been 50 per cent financed by the Export Development Corporation, 25 per cent by C.E.D.A. and 25 per cent by commercial companies.

The following table gives the average 1975/76 value of goods and services provided for the Canadian railway industry.

SECTOR PERFORMANCE
VALUE OF GOODS AND SERVICES PROVIDED
AVERAGE OF 1975/76

SUB SECTORS	SALES (CURRENT $ MILLION)	EXPORTS (CURRENT $ MILLION)	IMPORTS (CURRENT $ MILLION)	EMPLOY-MENT	REAL GROWTH 1970-1976 AVERAGE/YR.
Rolling Stock	$ 559.0	81.6	99.5	10,693	1.2%
Permanent Way Material	206.5	37.0	43.0	1,947	3.7%
Service Industries	755.5	12.0	.0	52,067	3.33%
TOTAL	$1,521.0	130.6	142.5	64,707	2.67%

Sector output averages approximately 0.9% of the GNP. Manufacturing capacity utilization averages 35-40%, but fluctuates irregularly between 10% and 100%, with a resultant adverse impact on productivity. This instability, coupled with low margins, provides neither the incentive nor the cash flow for plant productivity improvements or research and development projects.

It would appear reasonable to assume that the sector has excellent potential for growth in the export marketplace, providing suitable financing arrangements can be developed. This is particularly true of exporting to third world countries.

CAPABILITY OF ONTARIO BASED INDUSTRY TO PRODUCE NEW RAIL TECHNOLOGY

The development of new technology to meet the needs of Canada's railway systems is a continuous industrial task. The processes and techniques used to develop new technology in the plant is also in a constant state of change. New materials and designs have revolutionized the railway industry over the past ten years. Increased speed has called for major advances in rail car suspension systems with lighter car superstructures.

In this advanced rail systems development field, Ontario based industry is equal to its foreign competitors as suppliers of high technology rail hardware. A number of Ontario based companies are active in research and development. For example: Hawker Siddeley Canada Ltd., Thunder Bay, is actively involved in packaging research for rail cars; Bert Pyke Ltd., Oshawa, developed a range of track maintenance equipment; National Steel Car Corporation Ltd., Hamilton, operate research and development programs directed towards casting research and truck development; Procor Ltd., Oakville, carry out limited research and development on rail car design; Canron Railgroup, Toronto, maintain some 5 per cent of their R&D in Canada and 95 per cent at their branch plant in the United States; Canadian General Electric, Peterborough, General Motors of Canada Ltd., London and a number of other major Ontario railway manufacturing companies carry out no research and development in Canada at this time. They do, however, have the capability and staff to establish such programs.

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